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Distrbution and diversity of butterflies (Insect: order lepidoptera) in some urban habitats at Lucknow, India

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Abstract
Green area of Lucknow city to attract wide variety of butterfly fauna, which play a vital role in pollination of various flowering plants besides a key component of food chain. The investigation on species diversity and abundance was carried out in some distinct habitat types; within the Lucknow *viz*. gardens, parks green areas. Regular survey was conducted during day time (7.00AM-11.00AM). Nine hundred and forty individuals of butterflies have seen from various study sites, which include 38 identified species belonged to 29 genera and Six families *viz*., Nymphalidae-Brush-footed Butterfly family was the most dominant with 11 species followed by Pieridae-white and yellows (10), Lycaenidae-blues (6), Danaidae-The tigers (4), Hespiridae-skippers (4), Papilionidae-swallotails (3). During work five different urban habitats of Lucknow were selected for extensive sampling to determine the butterflies. The diversity was calculated by using diversity indices namely: Simpson's index (D), (1-D), (1/D), Margalef's index (d) and Shannon-Wiener index (H'). All sites were selected on the basis of their position in vegetation and accessibility.

Keywords: Distribution, species diversity, urban habitats, indices

Introduction

This study comprehensively examines the diversity and Distribution of butterfly populations across six families—Pieridae, Nymphalidae, Lycaenidae, Hesperiidae, Danaidae and Papilionidae in the district Lucknow The biodiversity evaluation is the process of measuring the value of biodiversity components, such as the number of species present, the population of a species, a habitat or the sum of all such components within a given area or site (David etal., 2005). Biodiversity is the contraction of biological diversity. The word biodiversity is now very widely used not only by the scientific community, but also the general public, environmental, groups, conservationists, industrialist and economists. It is also gained a very high profile in the national and international political arena.

Butterflies are the most beautiful and colorful creatures on the earth and have a great aesthetic value. More than 17000 species of butterfly are found all over world of these India is home to about 1501 species of butterfly which constitute 65% of total Indian fauna. Various ecosystems of our country support different species of butterfly. The Western Ghats alone support 330 species, out of which 48 are endemic to Nilgiri Biosphere reserve. About 50% of butterfly species of India is found in the state of Assam. The exact status of butterflies particularly of northern and central region of India is still not clearly known due to lack of proper study.

Among insects, butterflies are certainly most popular and eminent group. Butterflies occupy a vital position in ecosystems and their occurrence and diversity are considered as good indicators of the health of any given terrestrial biotope (Aluri and Rao, 2002; Kunte, 2000) [1, 25]. Butterflies and moths (order Lepidoptera) offer good opportunities for studies on population and community ecology (Pollard, 1991) [28].

India hosts about 1,504 species of butterflies (Tiple, 2011) [38] of which peninsular India hosts 351 and the western Ghat 334. In central India the butterfly species diversity was reported earlier by D'Abreu (1931) [10] and documented total 177 species occurring in the erstwhile Central Provinces (now Madhya Pradesh and Vidarbha). Some habitats components that influence the patterns of the butterfly diversity are determine by abiotic and biotic factors such as vegetation including host plants, food availability, temperature and wind exposure (Khan etal. 2004; Jain and Jain, 2012; Kharat etal.2012; Kumaraswamy and Kunte. 2013) [13, 14, 15, 22]. In open grassy habitats we can find the major components of butterflies diet, which include flower nectar, sap, fruit juices, carrion, scat and wetland moisture (Weber,2002) [42]. The resources such as host plants and food sources for butterflies available in grassy areas make them indispensable sites for their survivor and consequently for our survey

In Bir Shikargarh Wildlife Santury, Haryana, a total of 24 Butterflies species belonging to four families *viz* Nymphalidae Papilionidae, Pieridae and Lycaenidae were documented during the survey (Uniyal and Bhargav, 2007). Singh, 2009 [33, 40] a total of 3617 individuals of 147 species of butterflies were recorded during 11 sampling survey out in Kedranath musk deer reserve, Garhwal Himalaya. Kumar, 2011, 2012 & 2014 [17, 18, 19] total of species 23 belonging to 4 families, 27 species belonging to 5 families and 38 species belonging to 6 families respectively were detected from the different sites of in and around Jhansi. 70 species of butterflies belonging to 45 genera were recorded in the regional research laboratory campus, Jorhat, Assam, maximum number of species were observed in the family Nymphalidae (40), followed by Papilionidae (12), Pieridae (10), Lycaenidae (5) and Hespiridae (3) observed by Bhuyan etal. 2005 [3]. The present study was started with a view to examine the diversity and dynamics of butterfly population across seasons and some urban habitats in Lucknow. Despite its limitations, this study did attempt, perhaps for the first time, butterfly monitoring in central India with wide objectives of study.

Materials and Methods

Lucknow is west-central part of State Uttar Pradesh, India at 26.85 ^{0}N and 80.95 ^{0} E latitude. This region has tropical dry equable climate having three main seasons i.e. cold, summer and rainy. Five contrasting forest areas were chosen in the present study depending upon the complexity of habitat structure. Thick vegetation assemblage with closed canopy cover, edges of forest and area of human intervention in and around Lucknow were studied for butterfly diversity and has been referred to as Study site-1 (LU Campus), Study site-2 (Lohia Park), Study site-3 (Janeshwar Mishra Park), Study site-4 (Bijli Pasi fort), and Study site-5 (Smriti Upvan) Survey of all study sites was done for butterfly sampling for one year from August 2009 to July 2010. All surveys and sampling were limited to day time from 7.00 am to 11.00 am, when butterflies were more active. Temperature and humidity were also recorded. All the butterflies on the line as well 50m. on each side were recorded with respective time and number of individuals seen butterflies were identified directly in each site or in any difficult case following photography and identification following Wynter-Blyth 1957; Kunte 1996,1997 [23, 24, 43] & 2002. No capture or collection was made during the present study.

Data Analysis

The diversity was calculated by using diversity indices namely: Simpson's index (D), (1-D), 1/D (1949), Margalef's index (d) (1969) [26, 32] and Shannon-Wiener index (H') (1963) [29].

Results and Discusion

Nine hundred and forty individuals of butterflies collected from various study sites, which include 29 genera and 38 identified species belonging in six families (Table-1). Nymphalidae-Brush-footed Butterfly family was the most dominant with 11 species followed by Pieridae-White and yellows (10), Lycaenidae-Blues (6), Danaidae-The tigers (4), Hespiridae-Skippers (4), Papilionidae-Swallotails (3).

SS 1: 178 butterflies belong to 38 species collected, these are Atella phalanta (4), Precis lemonias (1), Precis orithya (2), Precis hierta (2), Precis atlites (4), Hypolimnas missipus (3), Hypolimnas bolina (2,)Argynnis hyperbius (4), Euthalia nais (3) , Ergolis merione (1), Byblia ilithyia (4), Ixias marianne (21), Catopsilia pyranthe (4), Catopsilia florella (3), Eurema brigitta (33), Catopsilia crocale (6), Anaphaeis aurota (8), Cepora nerissa (5), Colotis fausta (2),Terias laeta (2), Terias hecabe (2), Chilades prrhasius (6), Zizina otis (2), Catochrysops strabo (2), Lampides boeticus (6), Tarucus extricatus (3), Azanus jesous (4), Danaus genutia (5), Danaus chrysippus (6), Tirumala limniace (3) Euploea core (3), Udaspes folus (4), Telicota ancila (3),Tatractrocera maevius (4), Potanthus confucius (2), Papilio demoleus (4) Papilio ploytes (4), Pachliopta aristolochiae (1);

SS 2: 250 butterflies belong to 37 species recorded, these are Atella phalanta (5), Precis lemonias (2), Precis orithya (11), Precis hierta (6), Precis atlites (10), Hypolimnas missipus (4), Hypolimnas bolina (4,)Argynnis hyperbius (5), Euthalia nais (7) , Byblia ilithyia (6), Ixias marianne (33), Catopsilia pyranthe (3), Catopsilia florella (4), Eurema brigitta (49), Catopsilia crocale (3), Anaphaeis aurota (3), Cepora nerissa (6), Colotis fausta (1),Terias laeta (4), Terias hecabe (6), Chilades prrhasius (2), Zizina otis (3), Catochrysops strabo (3), Lampides boeticus (8), Tarucus extricatus (1), Azanus jesous (3), Danaus genutia (8), Danaus chrysippus (1), Tirumala limniace (5) Euploea core (7), Udaspes folus (9), Telicota ancila (2),Tatractrocera maevius (6), Potanthus confucius (6), Papilio demoleus (8) Papilio ploytes (6), Pachliopta aristolochiae (1)

SS-3: 174 butterflies belong to 37 species recorded, these are Atella phalanta (3), Precis lemonias (8, Precis orithya (2), Precis hierta (5), Precis atlites (8), Hypolimnas missipus (3), Hypolimnas bolina (2,) Argynnis hyperbius (2), Euthalia nais (4) , Ergolis merione (2), Byblia ilithyia (5), Ixias marianne (17), Catopsilia pyranthe (3), Catopsilia florella (2), Eurema brigitta (32), Catopsilia crocale (2), Anaphaeis aurota (1), Cepora nerissa (8), Colotis fausta (1), Terias laeta (3), Terias hecabe (2), Chilades prrhasius (2), Zizina otis (1), Lampides boeticus (7), Tarucus extricatus (1), Azanus jesous(5), Danaus genutia (4), Danaus chrysippus (6), Tirumala limniace (2) Euploea core (5), Udaspes folus (8), Telicota ancila(1),Tatractrocera maevius(3), Potanthus confucius (4), Papilio demoleus (5) Papilio ploytes(4), Pachliopta aristolochiae (1);

SS 4: 172 butterflies belong to 35 species recorded, these are Atella phalanta (2), Precis lemonias (2), Precis orithya (4), Precis hierta (3), Precis atlites (5), Hypolimnas missipus (2), Hypolimnas bolina (3), Argynnis hyperbius (5), Euthalia nais (5) , Byblia ilithyia (3), Ixias marianne (15), Catopsilia pyranthe (4), Catopsilia florella (5), Eurema brigitta (39), Catopsilia crocale (1), Anaphaeis aurota (3), Cepora nerissa (6), Colotis fausta (3),Terias laeta (4), Terias hecabe (5),Chilades prrhasius (2), Catochrysops strabo (2), Lampides boeticus (4), Azanus jesous (2), Danaus genutia (2), Danaus chrysippus (4), Tirumala limniace (3) Euploea core (6), Udaspes folus (6), Telicota ancila(1),Tatractrocera maevius(5), Potanthus confucius (4), Papilio demoleus (6) Papilio ploytes (4), Pachliopta aristolochiae (3);

SS 5: 166 butterflies belongs to 37 species recorded, these are Atella phalanta (3), Precis lemonias (2), Precis orithya (8), Precis hierta (7), Precis atlites (4), Hypolimnas missipus (2), Hypolimnas bolina (3), Argynnis hyperbius (3), Euthalia nais (4) , Ergolis merione (2), Byblia ilithyia (2), Ixias marianne (12), Catopsilia pyranthe (4), Catopsilia florella (3), Eurema brigitta (28), Catopsilia crocale (4), Anaphaeis aurota (3), Cepora nerissa (7), Colotis fausta (1), Terias laeta (3), Terias hecabe (3), Chilades prrhasius (3), Zizina otis (2), Catochrysops strabo (4), Lampides boeticus (4), Tarucus extricatus (2), Azanus jesous (3), Danaus genutia (6), Danaus chrysippus (2), Tirumala limniace (4), Euploea core (8), Udaspes folus (3), Telicota ancila (2),Tatractrocera maevius (4), Potanthus confucius (2), Papilio demoleus (4) Papilio ploytes (4).

Ergolis merione is not found in both Ss4 and Ss2. Zizeeria otis and Tarucus extricates are also not found in Ss4. Catochrysops Strabo, Pachliopta aristolochiae are not found in Ss3 and Ss5 respectively. (Table-1). During the survey 205 butterflies (21.80%), 7 genera (24.13%), 11species (28.94%); 425 butterflies (45.21%), 7 genera (24.13%), 10 species (26.31%); 86 butterflies (9.14%), 6 genera (20.68%), 6 species (15.78%); 90 butterflies (9.42%), 3 genera (10.34%), 4 species (10.52%); 80 butterflies (8.37%), 4 genera (13.79%), 4 species (10.52%) and 55 butterflies (5.75%), 2 genera (6.89%), 3 species (7.89%) are

recorded in family Nymphalidae-Brush-footed butterfly, Pieridae-White and yellows, Lycaenidae-Blues, Danaidae-The tigers, Hespiridae-Skippers and Papilionidae-Swallotails respectively (Table-1)

The localities which yielded higher diversity (SS-1 and SS-2) have very dense vegetation and abundant flowering plants and high trees which provide very favorable habitat to the butterflies. Their larvae can easily find the host plants and the dense vegetation provide excellent shelter to the adult butterflies, particularly during the summer The Calculated values of this index showed that butterflies are more or less equally distributed at all the localities of district Jhansi because the statistics data did not show the much difference among the sites (Table-2)

Shannon-Wiener index (H'). Component ranged from 1.4387 **(**SS-4**)** to 1.5989 **(**SS-3**)**, indicating that the lowest equitability was calculated from *SS-4* and the highest diversity was calculated fromSS-*3.* Both the values indicate that the butterfly fauna is more or less evenly distributed at all the localities of Jhansi. (Table-2). The calculated values of Margalef's idex at the different localities of Jhansi city ranged from 23.7806 **(**SS-5**)** to 37.3488 (SS-2), indicating that butterflies are more abundant at *SS-2* and less Abundant at SS-5 remaining all the habitats show more or less the same abundance (Table-2) Simpson's index give the species abundance and diversity by D. As D increase diversity decrease and the Simpson's index is usually express as 1-D or 1/d. This index is heavily weighted towards the most abundant species and being less sensitive to species richness.

The calculated values of Simpson's index D ranged from. 2552 (SS-2) to. 3084 **(**SS-4**).** The calculated values of 1-D ranged from.6916 (SS-4) to. 7440 (SS-3). Similarly 1/D ranged from 3.2425 (SS-4*)* to 3.906 (SS-3). This index showed that the lowest abundance was obtained from SS-4 and the highest abundance was obtained from SS-2. The flora of the SS-2 is densely rich which supported high diversity whereas, at SS-4 lower diversity was due to reason that the difficult terrain could not be sampled properly

Similar studies have been conducted in other part of India, like in the Kerala (Nair, 2002) [27], Poonch and Sudhnoti, Azad Kashmir (Khan, etal. 2004) [14], Birshikargarh wildilife sanctuary, Haryana (Uniyal and Bhargav,2007) [40], Nashikand Dhuledistricts Maharashtra (Kharat, etal. 2012) [15], Jhansi, Uttar Pradesh (Kumar, 2011, 2012 & 2014, Kumar & Ratnakar, 2013), Lucknow (Kumar and Rana , 2018, Kumar, 2020 Sushmita, etal.2021, 2022, Babita, etal.2022) [16, 17, 18, 19, 20, 21, 30, 36] and Hadoti region, Rajasthan (Jain & Jain, 2012) [13]; It is likely that relative impoverishment of the present butterfly fauna of four sites of Jhansi is due to the much greater extend and persistence of rural man and livestock-related deforestation(Versteeg and Ruiz,1995; Beers etal. 1997) [2, 41]. In the recent past, several researchers have studied butterflies from some districts and conservation areas of Madhya Pradesh and Chhattisgarh (Singh, 1977; Gupta, 1987; Chaudhury, 1995; Chandra *et al*., 2000a, b; 2002; Singh & Chandra, 2002; Siddiqui & Singh, 2004; Chandra, 2006; Tiple, 2012). Chandra *et al*. (2007) [4, 5, 6, 8, 9, 12, 31, 35, 39] recorded 174 species of butterflies belonging to eight families from Madhya Pradesh and Chhattisgarh.

The present study is the first of this type of study in the area. Therefore, it is very difficult to say whether the diversity of butterflies in the area is increasing or decreasing. Therefore, it is suggested that the area under the study should be continuously monitored to observe any change in the discovery of butterflies, because the changes in the diversity can only observed through continuous monitoring and comparing the data of every year. As the district was undergoing urbanizing many new residential colonies were getting established. Establishing residential colonies means cutting of trees and other supporting plants for shelter of butterflies, in turn increasing pollution, soil erosion etc. All these factors add up destruct the natural habitat. Despite the dry weather of Lucknow district, occurrence of 38 species was a vital sign of healthy biodiversity. In order to maintain and further enhance this picture it is necessary to conserve the biodiversity for achieving sustainable development.

Table 1: Total number and percentage of individuals, genera and species of different family

S.N.	Family	Total Individuals	Individuals (%)	Total Genera	Genera (%)	Total Species	Species (%)
1	Nymphalidae	205	21.80	7	24.13	11	28.94
2	Pieridae	425	45.21	7	24.13	10	26.31
3	Lycaenidae	86	9.14	6	20.68	6	15.78
4	Danaide	90	9.42	3	10.34	4	10.52
5	Hespiridae	79	8.27	4	13.79	4	10.52
6	Papilionidae	55	5.75	2	6.89	3	7.89
	Total	940		29		38	

Table 2: Calculated values of diversity indices different habitats at Lucknow

S.N.	Study Sites	Total species	Simpson's index (D)	Simpson's index (1-D) of diversity	Simpson's reciprocal index (1/D)	Margalef's index (d)	Shannon-Wiener index(h)
1	Ss 1	181	.2973	.7027	3.3636	25.9690	1.4503
2	Ss 2	257	.2552	.7248	3.6337	37.3488	1.506
3	Ss 3	174	.2560	.7440	3.906	25.0937	1.5989
4	Ss 4	177	.3084	.9616	3.2425	25.3885	1.4387
5	Ss 5	166	.2563	.7437	3.9016	23.7806	1.511

SS-1 LU Campus, SS-2 Lohia Park, SS-3 Janashwar Mishra Park, SS-4 Bijli Pasi Fort, SS-5 Smriti Upvan

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