Entomology

Preliminary study on the butterfly diversity of Aurangabad town and surrounding rural areas in Bihar, India

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Abstract

The butterflies are the important component and play pivotal role in environment. The study of butterfly of Bihar province is very less. The present study focused mainly on identification and finding the diversity of butterfly in Aurangabad town and adjacent rural areas in Bihar province, India. This was the preliminary study and was carried out during period July 2022 to June 2023. This study mainly focuses on identification of species and finding out their diversity. A total 48 butterfly species recorded Aurangabad and surrounding rural areas. Aurangabad township area had total of 23 species of butterflies under 5 families and 20 genera whereas surrounding rural areas had rich butterfly diversity comprising of 48 species belonging to 5 families and 42 genera. Maximum diversity was recorded in winter whereas minimum diversity in summer. Township area had fewer species, low diversity, evenness indices as well as high dominance index. Family Nymphalidae represented by maximum number of species. Rural areas had least disturbance and pollution hence maximum diversity than township area of Aurangabad (Bihar). The Results of this study suggest that suggest that industrialization, urbanization affect the butterfly diversity adversely. Rural areas have much vegetation, less disturbance and much habitat area holds great number of butterfly diversity. The index of similarity between two areas of study is found as 0.65.

Keywords: Aurangabad (Bihar), butterfly diversity, effect of industrialization, evenness, dominance & similarity indices, ecological indicator and Nymphalidae

1. Introduction

Butterfly diversity is not evenly distributed in the world. Species diversity is an indication of Bio-diversity in a specific ecological community. Butterflies play very pivotal role in ecosystem functioning. There is co-evolutionary relationship between plants and butterflies [1]. In nature they also play very significant role in pollination [2, 3]. They also help in controlling the number of plants and insect population [4]. Butterflies belong to order Lepidoptera of class Insecta of phylum Arthropoda. There are about 200.000 known species of Lepidoptera, of which about 10% are butterflies. India is rich in diversity with 1504 of butterfly species which accounted 8.74% of the world's butterfly and 285 species found in southern India. The peninsular India and Western Ghats have 351 and 334 species respectively [5]. Butterflies are classified into six families: the Pieridae, commonly known as whites and sulphurs; the Papilionidae, or swallowtails; the Nymphalidae, including the morphos, the owl butterfly and the long wings; the Hesperidae, or skippers; the Libytheidae, or snout butterflies; and the small Lycaenidae. These makes important components of terrestrial community structure and their loss makes adverse effects on ecosystem functioning and positively related with plant diversity [6, 7]. Butterflies diversity depends on change in microclimate [8]. Change in vegetation structure of any area may also cause a change in butterfly diversity of that particular area [9]. These are also the good indicator of habitat quality and act as tools for bio-diversity studies [10, 11]. Anthropogenic disturbances like urbanization and industrialization cause rapid migration or sometimes local extinction of butterflies [12]. In recent years butterflies of India have been investigated by several authors [13, 16].

The main objective of the present study is to investigate the butterfly diversity of Aurangabad (Bihar), and to prepare the checklist of butterfly of this area. This study also focused on how industrialization, urbanization as well as microhabitat disturbance affect butterfly diversity adversely.

2. Materials and methods

2.1. Study area and sampling sites

Present study was conducted in township area as well as surrounding rural areas as (Dhanari, Jamhore, Ketaki, Madanpur, obra, Pawai, Phesar and Sundarganj) of Aurangabad(Bihar). The district of Aurangabad (Bihar) lies between $24^0$45'- $24^0$75'N to $84^0$22' - $84^0$37'E. In township area there is high pollution and less vegetation whereas rural areas covers thick vegetation as well as less pollution. Average temperature of summer (March - June) is 29°C to 40 °C and average winter (October - February) temperature is 10 °C to 22 °C. the surrounding areas of Aurangabad is hilly with dense forest cover and thick vegetation suitable for butterfly bio-diversity. Aurangabad gets average rainfall of 1098 mm between june to October. The study area was spreading over 192 sq. km divided mainly into two zones viz Aurangabad township area and surrounding rural areas. For sampling and study we have selected 8 sampling sites from each zone. In township area sampling sites are (1) Ramesh chowk (2) Ramabandh Bus stand area (3) shree cement factory area (4) sinha college GT road area (5) Nawadih municipal dumping area (6) Karma road police line area (7) Adri river side area and (8) Kama Bigha area. Where as Aurangabad surrounding rural

areas sampling sites are (1) Dhanadi (2) Jamhore (3) Ketaki (4) Madanpur rural (5) Obra (6) Pawai (7) Phesar (8) Sundarganj. The average aerial distance between two smapling sites was about 5 km (Figure-1). The township area has fewer vegetation where as rural areas have rich floristic diversity. In some rural areas like ketaki madanpur show heavy forest and hilly areas. There is more butterfly species in rural areas than in township area.

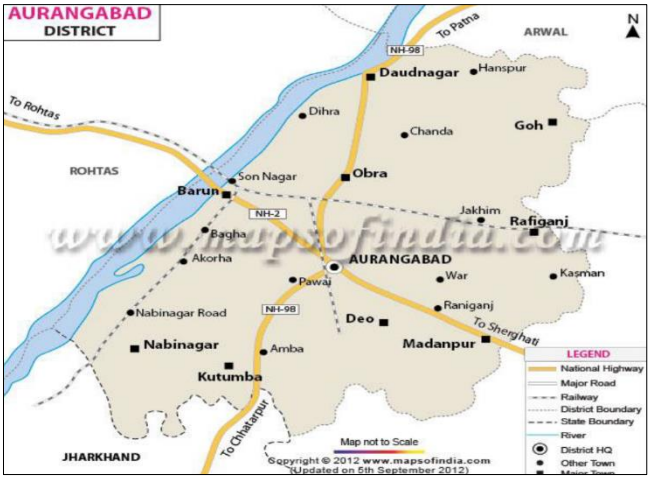


Fig 1: Map showing Aurangabad (Bihar) study area

2.2. Sampling techniques

The field survey was conducted during the period july 2022 to june 2023. Each study site was visited three times a month between 9 AM to 2 PM, during normal climatic condition with no strong wind and heavy rains. Butterflies accessed in the study area from 9am to 11am in the morning by random observations during walking through all the selected sites of the study area. In each of the site, two transect 1000 m long x 3 m width were taken with a gap of 300 m. a total of 6 km transect path followed during each visit. Butterflies were counted on either side of this transects. Same sampling procedure was followed during each visit to reduce the number variables as suggested by [17]. The number of individuals of butterflies belonging to different species were counted along transect following following Pollard walk method [18, 19].

Photographs of the butterflies were taken with the aid of camera for the identification purpose based on [20].

2.3. Identification and documentation

Butterflies were photographed by good quality digital Nikon D3200 camera. Some of the specimen were captured using butterfly hand net and after photography and identification released in the same habitat with least disturbance of their body. All the data were recorded with date, place and associated plants. Species level identification was done with the help of standard field guides and taxonomic literatures [21, 24].

2.4. Statistical analysis

The butterfly community structure were analyzed in terms of abundance, relative abundance, Shannon diversity index, Simpson's dominance index, Pielou's evenness index using the PAST software. Dominance status of each species was determined on the basis of relative abundance following Engelmann's scale [25]. Similarity or otherwise of the butterfly species composition was determined follow Sorensen's Index of similarity [26].

3. Results and discussion

48 species of butterflies belonging to 5 families and 42 genera were recorded from Aurangabad and surrounding rural areas (Table 1). Of these 23 species belonging to 5 families and 20 genera were recorded from Aurangabad Township area and surrounding rural areas holds 48 species of butterflies belonging to 5 families and 42 genera (Table 1). There were 23 common butterfly species to both the zones and Sorenson index of similarity was found to be 0.65 reveals that both the study areas were somehow similar in respect to the butterfly species composition (Table 1).

Table 1: Checklist of butterflies in Aurangabad town and surrounding rural areas

Sl No.	Common Name	Scientific Name	Township Area	Rural Area
Family - Pieridae				
Subfamily - Coliadinae				
1.	Common Emigrant	*Catopsilia pomona* (Fabricius, 1775)	-	+
2.	Mottled Emigrant	*Catopsilia pyranthe* (Linnaeus, 1758)	+	+
3.	Common Grass Yellow	*Eurema hecabe hecabe* (Linnaeus, 1758)	-	+
4.	One Spot Grass Yellow	*Eurema andersoni Jordani* (Corbet & Pendlebury, 1932)	+	+
Subfamily - Pierinae				
5.	Common Gull	*Cepora nerissa evagete* (Cramer, 1779)	+	+
6.	Yellow Orange Tip	*Ixias pyrene sesia* (Fabricius, 1777)	-	+
7.	Striped Albatross	*Appias libythea olferna* (Swinhoe, 1890)	-	+
8.	Indian Cabbage White	*Pieris canidia* (Linnaeus, 1768)	-	+
9.	Common Jezebel	*Delias eucharis* (Drury, 1773)	-	+
10.	Psyche	*Leptosia nina nina* (Fabricius, 1793)	+	+
11.	Common Wanderer	*Pareronia valeria hippia* (Fabricius, 1787)	+	+
12.	Small Salmon Arab	*Colotis amata modestus* (Butler, 1876)	-	+
Family - Papilionidae				
Subfamily - Papilioninae				
13.	Tailed Jay	*Graphium agamemnon menides* (Fruhstorfer, 1904)	+	+
14.	Common Rose	*Pachliopta aristolochiae aristolochiae* (Fabricius, 1775)	+	+
15.	Common Mime	*Papilio clytia clytia* (Linnaeus, 1758	-	+
16.	Common Mormon	*Papilio polytes romulus* (Cramer, 1775)	+	+

17.	Lime Butterfly	*Papilio demoleus demoleus* (Linnaeus, 1758)	+	+
Family - Lycaenidae				
Subfamily - Miletinae				
18.	Apefly	*Spalgis epius epius* (Westwood, 1852	-	+
Subfamily - Aphnaeinae				
19.	Common Silverline	*Spindasis vulcanus vulcanus* (Fabricius, 1775)	+	+
20.	Slate Flash	*Rapala manea schistacea* (Moore, 1879)	-	+
Subfamily - Polyommatinae				
21.	Ciliate Blue	*Anthene emolus emolus* (Godart, 1824)	-	+
22.	Dark Grass Blue	*Zizeeria karsandra* (Moore, 1865)	+	+
23.	Plains Cupid	*Luthrodes pandava* (Horsfield, 1829)	-	+
24.	Gram Blue	*Euchrysops cnejus* (Fabricius, 1798)	-	+
25	Pale Grass Blue	*Pseudozizeeria maha* (Kollar, 1844)	+	+
26.	Pointed Ciliate Blue	*Anthene lycaenina lycaenina* (Felder, 1868	-	+
27.	Lime Blue	*Chilades lajus lajus (*Stoll, 1780)	-	+
Subfamily - Theclinae				
28.	Falcate Oakblue	*Mahathala ameria* (Hewiton, 1862)	-	+
Family - Nymphalidae				
Subfamily - Danainae				
29.	Blue Tiger	*Tirumala limniace exoticus* (Gmelin, 1790)	+	+
30.	Common Tiger	*Danaus genutia genutia* (Cramer, 1779)	+	+
31.	Plain Tiger	*Danaus chrysippus chrysippus* (Linnaeus, 1758)	+	+
32.	Common Crow	*Euploeini core core* (Cramer, 1780)	+	+
33.	Double Branded crow	*Euploea sylvester* (Fabricius, 1793)	-	+
Subfamily - Satyrinae				
34.	Common Palm fly	*Elymnias hypermnestra undularis* (Drury, 1773)	-	+
35.	Common Bush Brown	*Mycalesis perseus* (Fabricius, 1775)	-	+
Subfamily - Acraeinae				
36.	Tawny Coster	*Acraea violae* (Fabricius, 1793)	+	+
Subfamily - Heliconiinae				
37.	Common Leopard	*Phalanta phalantha phalantha* (Drury, 1773	+	+
Subfamily - Limenitidinae				
38.	Common Baron	*Euthaliaacontheaanagama* (Fruhstorfer, 1913)	-	+
Subfamily - Biblidinae				
39.	Angled Castor	*Ariadne ariadne indica* (Moore, 1884)	+	+
Subfamily - Nymphalinae				
40.	Peacock Pansy	*Junonia almanac almana* (Linnaeus,1758)	+	+
41.	Grey Pansy	*Junonia atlites atlites* (Linnaeus, 1763)	+	+
42.	Blue Pansy	*Junonia orithya swinhoei* (Butler, 1885	-	+
Family - Hesperiidae				
Subfamily - Hesperiinae				
43.	Dark Palm Dart	*Telicota bambusae* (Moore, 1878)	-	+
44.	Bush Hopper	*Ampittia dioscorides dioscorides* (Fabricius, 1793)	+	+
45.	Grass Demon	*Udaspes folus* (Cramer, 1775)	-	+
46.	Rice Swift	*Borbo cinnara* (Wallace, 1866)	-	+
47.	Small branded Swift	*Pelopidas thrax* (Huebner, 1821)	+	+
48.	Banana Skipper	*Erionota torus* (Evaus, 1941)	-	+
No. of Species			23	48
SØrensen's Index of Similarity			0.65	

Table 2A: Dominance status of species recorded from township area

Sl No.	Common Name	Scientific Name	Abundance	Relative Abundance (%)	Dominance Status*
Family - Pieridae					
Subfamily - Coliadinae					
1.	Mottled Emigrant	*Catopsilia pyranthe* (Linnaeus, 1758)	140	7.442	SD
2.	One Spot Grass Yellow	*Eurema andersoni Jordani* (Corbet & Pendlebury, 1932)	80	4.253	SD
Subfamily - Pierinae					
3.	Common Gull	*Cepora nerissa evagete* (Cramer, 1779)	29	1.541	R
4.	Psyche	*Leptosia nina nina* (Fabricius, 1793)	96	5.103	SD
5.	Common Wanderer	*Pareronia valeria hippia* (Fabricius, 1787)	40	2.126	R
Family - Papilionidae					
Subfamily - Papilioninae					
6.	Tailed Jay	*Graphium agamemnon menides* (Fruhstorfer, 1904)	52	2.764	R

7.	Common Rose	*Pachliopta aristolochiae aristolochiae* (Fabricius, 1775)	145	7.708	SD
8.	Common Mormon	*Papilio polytes romulus* (Cramer, 1775)	104	5.528	SD
9.	Lime Butterfly	*Papilio demoleus demoleus* (Linnaeus, 1758)	243	12.918	D
Family - Lycaenidae					
Subfamily - Aphnaeinae					
10.	Common Silverline	*Spindasis vulcanus vulcanus* (Fabricius, 1775)	81	4.306	SD
Subfamily - Polyommatinae					
11.	Dark Grass Blue	*Zizeeria karsandra* (Moore, 1865)	09	0.478	SR
12.	Pale Grass Blue	*Pseudozizeeria maha* (Kollar, 1844)	02	0.106	SR
Family - Nymphalidae					
Subfamily - Danainae					
13.	Blue Tiger	*Tirumala limniace exoticus* (Gmelin, 1790)	345	18.341	D
14.	Common Tiger	*Danaus genutia genutia* (Cramer, 1779)	47	2.498	R
15.	Plain Tiger	*Danaus chrysippus chrysippus* (Linnaeus, 1758)	61	3.242	SD
16.	Common Crow	*Euploeini core core* (Cramer, 1780)	32	1.701	R
Subfamily - Acraeinae					
17.	Tawny Coster	*Acraea violae* (Fabricius, 1793)	77	4.093	SD
Subfamily - Heliconiinae					
18.	Common Leopard	*Phalanta phalantha phalantha* (Drury, 1773	99	5.263	SD
Subfamily - Biblidinae					
19.	Angled Castor	*Ariadne ariadne indica* (Moore, 1884)	41	2.179	R
Subfamily - Nymphalinae					
20.	Peacock Pansy	*Junonia almanac almana* (Linnaeus,1758)	53	2.817	R
21.	Grey Pansy	*Junonia atlites atlites* (Linnaeus, 1763)	32	1.701	R
Family - Hesperiidae					
Subfamily - Hesperiinae					
22.	Bush Hopper	*Ampittia dioscorides dioscorides* (Fabricius, 1793)	44	2.339	R
23.	Small branded Swift	*Pelopidas thrax* (Huebner, 1821)	29	1.541	R
* RA<1 = Subrecedent (SR); 1.1-3.1 = Recedent (R); 3.2-10 = Subdominant (SD); >10.1 31.6 = Dominant (D)					

Table 2B: Dominance status of species recorded from rural areas

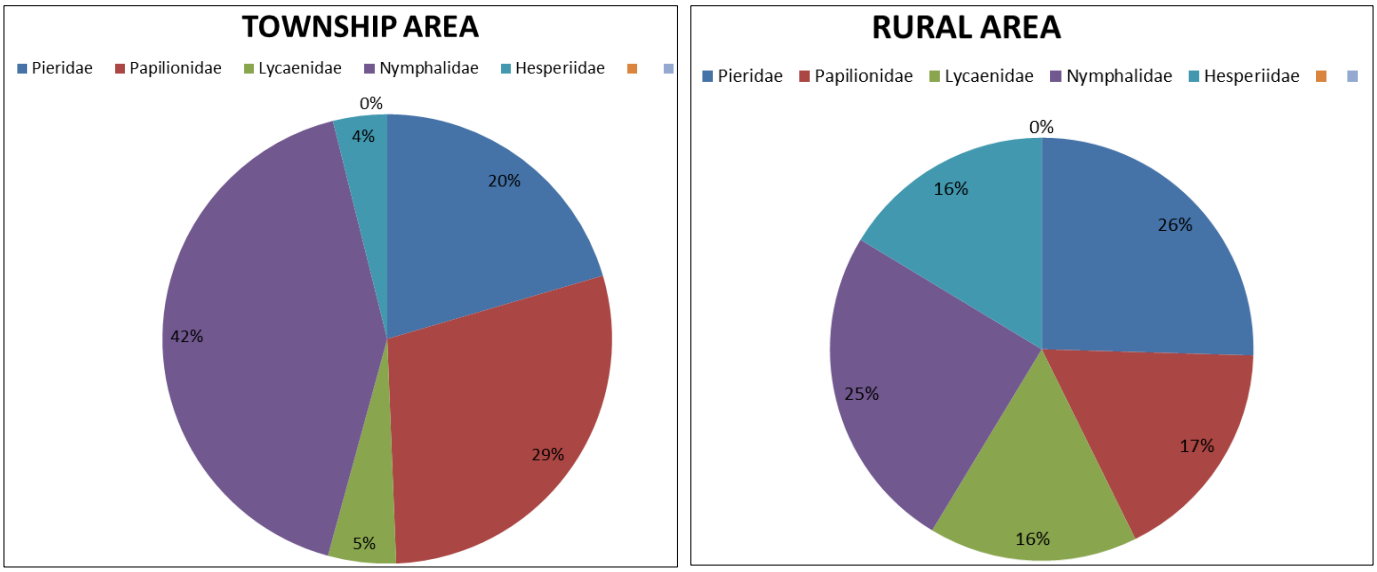
Sl No.	Common Name	Scientific Name	Abundance	Relative Abundance (%)	Dominance Status*
Family - Pieridae					
Subfamily - Coliadinae					
1.	Common Emigrant	*Catopsilia pomona* (Fabricius, 1775)	132	1.906	R
2.	Mottled Emigrant	*Catopsilia pyranthe* (Linnaeus, 1758)	188	2.715	R
3.	Common Grass Yellow	*Eurema hecabe hecabe* (Linnaeus, 1758)	172	2.484	R
4.	One Spot Grass Yellow	*Eurema andersoni Jordani* (Corbet & Pendlebury, 1932)	346	4.997	SD
Subfamily - Pierinae					
5.	Common Gull	*Cepora nerissa evagete* (Cramer, 1779)	151	2.180	R
6.	Yellow Orange Tip	*Ixias pyrene sesia* (Fabricius, 1777)	119	1.718	R
7.	Striped Albatross	*Appias libythea olferna* (Swinhoe, 1890)	144	2.079	R
8.	Indian Cabbage White	*Pieris canidia* (Linnaeus, 1768)	91	1.314	R
9.	Common Jezebel	*Delias eucharis* (Drury, 1773)	34	0.491	SR
10.	Psyche	*Leptosia nina nina* (Fabricius, 1793)	171	2.469	R
11.	Common Wanderer	*Pareronia valeria hippia* (Fabricius, 1787)	193	2.787	R
12.	Small Salmon Arab	*Colotis amata modestus* (Butler, 1876)	22	0.317	SR
Family - Papilionidae					
Subfamily - Papilioninae					
13.	Tailed Jay	*Graphium agamemnon menides* (Fruhstorfer, 1904)	197	2.845	R
14.	Common Rose	*Pachliopta aristolochiae aristolochiae* (Fabricius, 1775)	112	1.617	R
15.	Common Mime	*Papilio clytia clytia* (Linnaeus, 1758	221	3.191	R
16.	Common Mormon	*Papilio polytes romulus* (Cramer, 1775)	271	3.913	SD
17.	Lime Butterfly	*Papilio demoleus demoleus* (Linnaeus, 1758)	393	5.675	SD
Family - Lycaenidae					
Subfamily - Miletinae					
18.	Apefly	*Spalgis epius epius* (Westwood, 1852	101	1.458	R
Subfamily - Aphnaeinae					
19.	Common Silverline	*Spindasis vulcanus vulcanus* (Fabricius, 1775)	203	2.931	R
20.	Slate Flash	*Rapala manea schistacea* (Moore, 1879)	92	1.328	R
Subfamily - Polyommatinae					
21.	Ciliate Blue	*Anthene emolus emolus* (Godart, 1824)	91	1.314	R
22.	Dark Grass Blue	*Zizeeria karsandra* (Moore, 1865)	97	1.400	R

23.	Plains Cupid	*Luthrodes pandava* (Horsfield, 1829)	96	1.386	R
24.	Gram Blue	*Euchrysops cnejus* (Fabricius, 1798)	20	0.288	SR
25	Pale Grass Blue	*Pseudozizeeria maha* (Kollar, 1844)	99	1.429	R
26.	Pointed Ciliate Blue	*Anthene lycaenina lycaenina* (Felder, 1868	108	1.559	R
27.	Lime Blue	*Chilades lajus lajus (*Stoll, 1780)	135	1.949	R
Subfamily - Theclinae					
28.	Falcate Oakblue	*Mahathala ameria* (Hewiton, 1862)	63	0.909	SR
Family - Nymphalidae					
Subfamily - Danainae					
29.	Blue Tiger	*Tirumala limniace exoticus* (Gmelin, 1790)	177	2.556	R
30.	Common Tiger	*Danaus genutia genutia* (Cramer, 1779)	102	1.473	R
31.	Plain Tiger	*Danaus chrysippus chrysippus* (Linnaeus, 1758)	197	2.845	R
32.	Common Crow	*Euploeini core core* (Cramer, 1780)	182	2.628	R
33.	Double Branded crow	*Euploea sylvester* (Fabricius, 1793)	39	0.563	SR
Subfamily - Satyrinae					
34.	Common Palm fly	*Elymnias hypermnestra undularis* (Drury, 1773)	104	1.502	R
35.	Common Bush Brown	*Mycalesis perseus* (Fabricius, 1775)	29	0.418	SR
Subfamily - Acraeinae					
36.	Tawny Coster	*Acraea violae* (Fabricius, 1793)	301	4.347	SD
Subfamily - Heliconiinae					
37.	Common Leopard)	*Phalanta phalantha phalantha* (Drury, 1773	132	1.906	R
Subfamily - Limenitidinae					
38.	Common Baron	*Euthalia aconthea anagama* (Fruhstorfer, 1913)	53	0.765	SR
Subfamily - Biblidinae					
39.	Angled Castor	*Ariadne ariadne indica* (Moore, 1884)	101	1.458	R
Subfamily - Nymphalinae					
40.	Peacock Pansy	*Junonia almanac almana* (Linnaeus,1758)	206	2.975	R
41.	Grey Pansy	*Junonia atlites atlites* (Linnaeus, 1763)	89	1.285	R
42.	Blue Pansy	*Junonia orithya swinhoei* (Butler, 1885	18	0.259	SR
Family - Hesperiidae					
Subfamily - Hesperiinae					
43.	Dark Palm Dart	*Telicota bambusae* (Moore, 1878)	44	0.635	SR
44.	Bush Hopper	*Ampittia dioscorides dioscorides* (Fabricius, 1793)	32	0.462	SR
45.	Grass Demon	*Udaspes folus* (Cramer, 1775)	291	4.202	SD
46.	Rice Swift	*Borbo cinnara* (Wallace, 1866)	443	6.398	SD
47.	Small branded Swift	*Pelopidas thrax* (Huebner, 1821)	311	4.491	SD
48.	Banana Skipper	*Erionota torus* (Evaus, 1941)	11	0.158	SR
* RA<1 = Subrecedent (SR); 1.1-3.1 = Recedent (R); 3.2-10 = Subdominant (SD); >10.1 31.6 = Dominant (D)					

The present study provide the preliminary outline about the butterfly diversity of Aurangabad (Bihar). Township area had lower number of Lepidopteran species as compared to rural areas.

Lower number of butterfly species in township area may be due some pollutants, disturbances as well as lack of vegetational area. Different researchers and scientiests have also suggested that butterfly diversity greatly affected by anthropogenic disturbances like habitat loss, pollution and lack of vegetational area. 23 species which were present in the township area are more toletant to pollutant as well as anthropogenic disturbances and 25 butterfly species that are exclusively confined to rural areas may considered more more sensitive to pollutants [27, 28, 29]. Because of complex utilization pattern, butterfly species are more sensitive to ecosystem health [30]. Any adverse changes in native vegetational composition by activities of man might also alter the species composition of butterflies. Even habitat loss of fragmentation may also lead to migration or migration or local extinction of native butterflies populations [31]. Change of land pattern of any area may lead to change in their native diversity [32].

During the study of butterfly diversity in township area of Aurangabad (Bihar) family Lycaenidae was the most common family with 7 species followed by Pieridae and Nymphaelidae (5 species), Papilionidae (4 species) and Hesperiidae (2 species) respectively. However percentage of samples of the family Nymphalidae was 41.47% followed by Papilionidae (28.92%), Pieridae (20.46%), Lycaenidae (4.89%) and Hesperiidae (3.89%) (Figure 2A). In rural areas family Nymphalidae was represented by 14 species followed by Pieridae (12 species), Lycaenidae (11 species), Hesperiidae (6 species) and Papilionidae (5 species) (Figure 2B). This indicates Nymphalidae is best adapted butterfly family and it dominates in different environmental conditions throughout the country. Lycaenidae, Pieridae and Hesperiidae were less frequent due to their low ecological tolerance and for their preference for relatively less disturbed habitats. Nymphalidae is polyphagus in nature, can live in variety of habitats and the species under this family are active fliers [33].



(A) (B)

Fig 2A-2B: Family wise percentage of individuals in two sites

An analysis of relative abundance revealed that in the township area 2 species viz., *Tirumala limniace exoticus*, *Papilio demoleus demoleus* were dominant and 9 species were subdominant in nature (Table 2A). In rural area there was no dominant species but 7 species were subdominant (Table 2B). The dominance index (C) was found to be notably lower in the rural zone (0.030) as compared to the industrial zone (0.080) (Table 3). This clearly suggests that industrial zone represents harsher environmental condition as compared to the nearby rural zone.

Table 3: Comparison of different indices of the study sites

Study sites	Shanon diversity index ($\bar{H}$)	Pielou evenness index (e)	Simpson dominance index (C)
Township area	2.79	0.712	0.080
Rurl area	3.64	0.796	0.030

There was little differences in diversity indices ($\bar{H}$) and evenness indices (e) which were relatively higher in vegetation rich rural area ($\bar{H}$= 3.64, e= 0.796) than industrial zone ($\bar{H}$= 2.79, e= 0.792) (Table 3). The diversity indices of industrial zone indicates moderate pollution level, anthropogenic disturbances and less vegetation in that area. Higher butterfly diversity in rural areas was also reported in Japan and this was due to agricultural landscape with rural areas which provides habitat heterogeneity and available host plant species [34, 35].

4. Conclusions

Present study revealed that, Aurangabad (Bihar) township area has less number of butterflies species, lower diversity and evenness indices and higher dominance index as compared to the surrounding rural areas. Findings suggest that urbanization as well as industrialization makes harsh environmental condition to butterflies diversity. This support family Nymphalidae better in this area. However these two areas under consideration were slightly similar in butterfly faunal composition as revealed by the index of similarity. This was due to close proximity of the two areas. However, the study suggests that butterflies have the potentiality to be used as good ecological indicator.

References

1. Ghazanfar M, Iqbal R, Malik MF, Younas M. Butterflies and their contribution in ecosystem: A review. Journal of Entomology and Zoology Studies. 2016;115(42):115-118.
2. Webb KJ. Beyond Butterflies: Gardening for Native Pollinators, The University of Georgia and Ft. Valley State University, the U.S. Department of Agriculture and counties of the state cooperating. Bulletin, 1349, University of Georgia, 2008 Nov 24. Handle: https://hdl.handle.net/10724/12342.
3. Shi J, Luo YB, Ran JC, Liu ZJ, Zhou Q. Pollination by deceit in Paphiopedilum barbigerum (Orchidaceae): a staminode exploits innate colour preferences of hoverflies (Syrphidae). Plant Biology. 2009;11:17-28.
4. Conrad KF, Fox R, Woiwod IP. Monitoring biodiversity: measuring longterm changes in insect abundance. Insect Conservation Biology (eds A.J.A. Stewart, 82 T.R. New & O.T. Lewis), CABI, Wallingford, 2007, 203–225.
5. Kunte K, Sondhi S, Samgma BM, Lovalekar R, Tokekar K, Agavekar G. Butterflies of the Garo Hills of Meghalaya northeastern India: Their diversity and conservation. Journal of the Threatened Taxa. 2012;4(10):2933-2992.
6. Altermatt F, Pearse IS. Similarity and specialization of the larval versus adult diet of European butterflies and moths. American Naturalist. 2011;178:372-382.
7. Leps J, Spitzer K. Ecological determinants of Butterfly communities (Lepidoptera, Papilionoidea) in the Tam Dao Mountains, Vietnam. Acta Entomologica Bohemoslovaca. 1990;87:182-194.
8. Fordyce JA, Nice CC. Variation in butterfly egg adhesion: Adaptation to level host plant senescence characteristics? Ecology Letters. 2003;6:23-27.
9. Koh LP. Impacts of land use change on South-east Asian forest butterflies: a review. Journal of Applied Ecology. 2007;44:703-713.
10. Menken SBJ, Boomsmas JJ, Van NJ. Large scale

evolutionary patterns of host plant associations in the Lepidoptera: Evolution. 2012;64:1098-1119.
11. Hortal J, Bello F, Alexandre J, Diniz-Filho F, Lewinsohn TM, Lobo JM. Seven shortfalls that beset large-scale knowledge of biodiversity. Annual Review of Ecology, Evolution and Systematics. 2015;46:523-549.
12. Mennechez G, Schtickzelle N, Baguette M. Metapopulation dynamics of the bog fritillary between a continuous and a highly fragmented butterfly: comparison of demographic parameters and dispersal landscape. Landscape Ecology 18 (2003) 279-291.
13. Ramesh T, Hussain KJ, Selvanayagam M, Satpathy KK, Prasad MVR. Patterns of diversity, abundance and habitat associations of butterfly communities in heterogeneous landscapes of the department of atomic energy (DAE) campus at Kalpakkam, South India. International Journal of Biodiversity and Conservation. 2010;2(4):75-85.
14. Raychaudhuri D, Saha S. Atlas of Insects and spiders of Buxa Tiger Reserve, West Bengal Biodiversity Board and Nature Books, India, 2014, p357.
15. Samanta S, Das D, Mandal S. Butterfly fauna of Baghmundi, Purulia, West Bengal, India: a preliminary checklist. Journal of Threatened Taxa. 2017;9(5):10198-10207.http://doi.org/10.11609/jott.2841.9.5.10198-10207.
16. Mohammed Abdullahi, Amit Larkin, Ashwani Kumar, Hemant Kumar, Adam Lawan Idris. A study on butterfly diversity in Prayagraj district of Uttar Pradesh, India. Int. J. Adv. Res. Biol. Sci. 2019;6(8):112-119. DOI: http://dx.doi.org/10.22192/ijarbs.2019.06.08.016
17. Pyle RM. Handbook for butterfly watchers, Houghton Mifflin Harcourt, Boston, 1992, p280.
18. Pollard E. A method for assessing changes in the abundance of butterflies. Biological Conservation. 1977;12:115-134.
19. Pollard E, Yates TJ. Monitoring Butterflies for Ecology and Conservation, Chapman and Hall, London, 1993, p292.
20. Smetacek P. A Naturalist's Guide to the Butterflies of India, John Beaufoy Publishing Ltd, Malaysia, 2017, p176.
21. Kehimkar I. Butterflies of India, Bombay Natural History Society, Oxford University Press, Mumbai, 2016, p528.
22. Wynter-Blyth MA. Butterflies of the Indian region, Bombay Natural History Society, Bombay, India, 1957, p523.
23. Varshney RK, Smetacek P. A Synoptic Catalogue of the Butterflies of India. Butterfly Research Centre, Bhimtal and Indinov Publishing, New Delhi, 2015, p261.
24. Dey PK, Payra A, Mondal K. A study on butterfly diversity in Singur, West Bengal, India. E-planet. 2017;15(1):73-77.
25. Engelmann HD. Zur Dominanzk classifizierung von Bodenarthropoden. Pedobiologia. 1978;18:378-380.
26. Sørensen T. A method of establishing groups of equal amplitude in plant sociology based on similarity of species and its application to analyses of the vegetation on Danish commons. Biologiske Skrifter Danske Videnskabemes Selskab. 1948;5(4):1-34.
27. Kunte K. Butterflies of Peninsular India, Universities Press Limited, Hyderabad, 2000, p272.
28. Thomas CD, Cameron A, Green RE, Bakkenes B, Beaumont LJ, Collingham YC, *et al*. Extinction risk from climate change. Nature. 2004;427(6970):145-148. http://doi.org/10.1038/nature 02121
29. Bonebrake TC, Ponisio LC, Boggs CL, Ehrlich PR. More than just indicators: a review of tropical butterfly ecology and conservation. Biological Conservation. 2010;143:1831-1841. https://doi.org/10.1016/j.biocon.2010.04.044.
30. Thomas J. Monitoring change in the abundance and distribution of insects using butterflies and other indicator groups. Philosophical Transactions of the Royal Society B: Biological Sciences. 2005;360(1454):339-357. http://doi.org/10.1098/rstb.2004.1585
31. Blair RB. Birds and butterflies along an urban gradient: surrogate taxa for assessing biodiversity? Ecological Applications. 1999;9:164-170.
32. Ghosh Sand Saha S. Seasonal diversity of butterflies with reference to habitat heterogeneity, larval host plants and nectar plants at Taki, North 24 Parganas, West Bengal, India. World Scientific News. 2016;50:197-238.
33. Majumder J, Lodh R, Agarwala BK. Butterfly species richness and diversity in the Trishna Wildlife Sanctuary in South Asia. Journal of Insect Science. 2013;13(79):1-13. http://www.insectscience.org/13.79.
34. Kitahara M and Sei K. A comparison of the diversity and structure of butterfly communities in Seminatural and human-modified grassland habitats at the foot of Mt. fuji, Central Japan. Biological Conservation. 2001;10:331-351.
35. Kuussaari M, Heliölä J, Luoto M, Pöyry J. Determinants of local species richness of diurnal Lepidoptera in boreal agricultural landscapes. Agriculture, Ecosystems & Environment. 2007;122:366-376. https://doi.org/10.1016/j.agee.2007.02.008.