



A STUDY ON THE BUTTERFLY DIVERSITY OF KOLAGHAT THERMAL POWER PLANT AND ADJACENT RURAL AREA IN PURBA MEDINIPUR DISTRICT, WEST BENGAL, INDIA

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ABSTRACT 65 species of butterflies under 5 families, collectively comprising 17 subfamilies and 49 genera were recorded from Kolaghat Thermal Power Plant area and adjacent rural area. Thermal Power Plant area had fewer species low diversity and evenness indices and high dominance index. Nymphalidae outnumbered all other families in the industrial zone with 52.4% of the total species of that area. Such preponderance of any single family was not evident in the rural area, likewise Thermal Power Plant had 4 dominant species but no dominant species could be seen in the rural area. Results suggest that Thermal Power Plant could alter the butterfly diversity but it was not enough to make the two sites dissimilar as revealed by the index of similarity (0.54).

KEYWORDS : Butterfly diversity, effect of thermal power plant , evenness, dominance and similarity indices, ecological indicator

INTRODUCTION

Butterflies are key pollinators in ecosystems, helping maintain the floral community structure across tropical regions. India supports a rich butterfly diversity, comprising 1318 species (Varshney and Smetacek, 2015). As integral components of terrestrial ecosystems, their decline can negatively affect overall ecosystem functioning (Altermatt and Pearce, 2011). Butterfly diversity is known to be positively correlated with plant diversity (Leps and Spitzer, 1990; Padhye et al., 2006). Because butterflies are highly sensitive to microclimatic changes (Fordyce, 2003), any alteration in vegetation structure can result in shifts in their diversity (Koh, 2007). Consequently, butterflies serve as rapid indicators of habitat quality (Ramana, 2010) and are considered one of the most suitable groups for biodiversity studies (Hortal et al., 2015).

However, anthropogenic activities such as urbanization and industrialization may lead to the migration or local extinction of butterfly species (Mennechez et al., 2003). In recent years, various researchers have documented butterfly diversity across India (Ramesh et al., 2010; Thakur and Mattu, 2010; Majumder et al., 2013; Tiple and Khured, 2009; Sengupta et al., 2014; Priya et al., 2017) In West Bengal, similar studies have been carried out by Ghosh and Siddique (2005), Chowdhury and Chowdhury (2006), Chowdhury and Soren (2011), Roy et al. (2012), Sanyal et al. (2012), Chowdhury (2014), Raychaudhuri and Saha (2014), Mukherjee et al. (2015), Ghosh and Mukherjee (2016), Ghosh and Saha (2016), Mandal (2016), Samanta et al. (2017), Dey et al. (2017) and Pahari et al. (2018).

The main objective of the present study is to examine the butterfly fauna of the Kolaghat Thermal Power Plant area in West Bengal and to determine whether industrialization and urbanization have exerted any adverse effects on butterfly density and diversity.

MATERIALS AND METHODS

Study Sites

Present study was conducted in Kolaghat Thermal Power Plant region and adjacent rural area (Figure 1). Kolaghat (22°24'56"N 87°52'12"E / 22.41556°N 87.87000°E) is one of the most rapidly growing industrial township in West Bengal situated on the tidal zone of the Rupnarayan basin. Average elevation of is 9 meters MSL. Kolaghat is predominantly a thermal power industrial belt. Kolaghat Thermal Power Station (KTPS) primarily belongs to the power generation sector, producing electricity. Its large coal requirement drives the coal mining and supply chain industries, while the substantial quantities of fly ash generated support the cement, brick manufacturing, and infrastructure (landfilling) sectors. In addition, the plant is linked to supporting industries such as engineering, procurement and construction (EPC) firms (e.g., BHEL, Siemens) and rail and road transport services. Every day considerable quantities of pollutants are released in air and water. Average temperature of summer (March - June) is 37°C to 41°C and average winter (October - February) temperature is 13.1 °C to 27.3°C. Kolaghat Thermal Power Station gets 1150 mm of rain mostly between June and September.

The study was conducted in an area spreading over 44,815,391.16 m² was divided into two zones viz. Kolaghat Thermal Power Plant

industrial zone (22°24'56"N 87°52'12"E / 2 2.41556°N 87.87000°E) having an area of 991,047.2 m² and the adjacent rural region (22°24'36.1"N 87°53'25.2"E) having an area of 43,824,343.96 m². 7 sampling sites were selected from each zone (Figure 1). Selected sampling sites in industrial zone were 1) Khanjadapur Ghes Ground, 2) Natsir more, 3) Kolaghat Electrical Sub-Station-I, 4) WBPDC Ash Park, 5) Kolaghat Electrical Sub-Station,-II, 6) Shantipur, 7) Barnan, and in adjacent rural area were 1) Jamittyta, 2) Kharui, 3) Babua, 4) Purba Bahala 5) Amalhanda. 6) Burari, 7) Banpur, The average aerial distance between two sampling zones was about 4.2 km. The industrial zone and adjacent rural area were also distinguished by their floral composition.

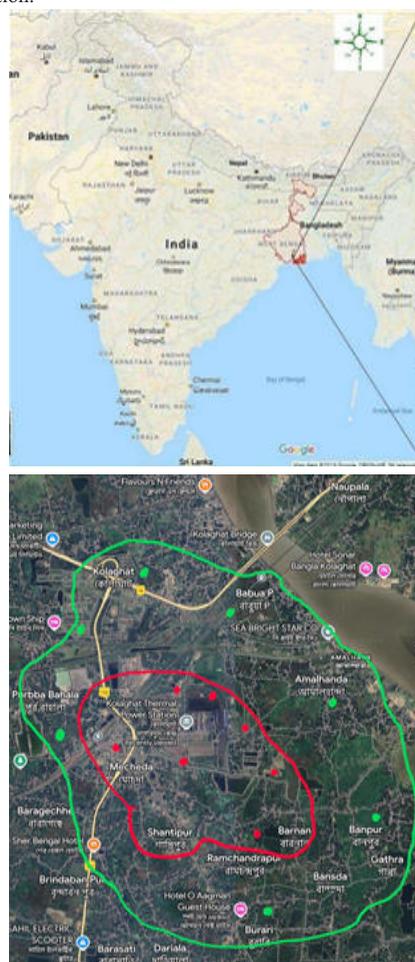


Figure 1. Map of Kolaghat Thermal Power Plant & adjoining rural area, West Bengal, Highlighting the Thermal Power Plant sampling site with red point & rural area with green point.

The rural area supported a higher floral diversity, with 35 plant species belonging to 19 families, whereas the industrial zone recorded only 17 species under 12 families. A total of 12 plant species were common to both study sites. *Rhizophora mangle* (Rhizophoraceae) and *Dioscorea* sp. (Dioscoreaceae) were observed exclusively in the rural area, while *Ixora* sp. and *Mussaenda laxa* of the family Rubiaceae, along with *Terminalia* sp. (Combretaceae), were predominantly found in the power plant area.

Sampling Techniques

The study was carried out over a one-year period from September 2021 to August 2022. Each site was surveyed twice every month between 7:00 AM and 4:00 PM under normal weather conditions, avoiding periods of strong winds and heavy rainfall. At each site, two transects measuring 1000 m in length and 4 m in width were established, with a distance of 250 m between them. Consequently, a total transect length of 5 km (1000 m × 5) was covered during each sampling event. Butterflies were recorded on both sides of the transects. The same transect routes were used during every survey to minimize variability, following the recommendations of Pyle (1992). Butterfly individuals of each species were counted along the transects using the Pollard walk method (Pollard, 1977; Pollard and Yates, 1993). The average Air Quality Index (AQI) was determined by recording air quality data during each survey in accordance with the Central Pollution Control Board guidelines (National Air Quality Index, 2021–2022).

Taxonomic Procedure And Documentation

Butterflies were photographed using a Canon EOS 850D digital camera. In a few cases, individuals were gently captured with a butterfly hand net for closer examination and, after accurate identification, were released back into the same habitat with minimal

disturbance to their wing scales. Each observation was carefully recorded with details of the date, location, and associated host plants. Species-level identification was conducted using standard field guides and taxonomic references, including Kehimkar (2016), Wynter-Blyth (2009), Varshney and Smetacek (2015), and Smetacek (2017).

Community Analysis

The structure of the butterfly community was analysed using measures such as abundance, relative abundance, Shannon diversity index, Simpson's dominance index, and Pielou's evenness index, all calculated with the help of PAST software. The dominance of individual species was determined based on their relative abundance following Engelmann's scale (Engelmann, 1978). In addition, similarities in butterfly species composition between the study sites were evaluated using Sørensen's Index of Similarity (Sørensen, 1948).

RESULT AND DISCUSSION

The present study documented a total of 65 species across the two study site combined, of which 54 species were recorded in the rural area and 35 species in the Thermal Power Plant area. All recorded butterflies belonged to 5 families, collectively comprising 17 subfamilies and 49 genera (Table 1). Of these 35 species belongs to 28 genera were collected from the Thermal Power Plant area and were 54 species under 47 genera were recorded in the rural area (Table 1). There were 24 species common to both the area and index of similarity was found to be 0.54 suggesting that the markedly higher species and genera richness in the rural area highlights its importance of butterfly conservation, while the comparatively impoverished assemblage in the industrial area indicates the negative influence of anthropogenic disturbance on butterfly diversity (Table 1).

Table 1. Checklist Of Butterflies In Kolaghat Thermal Power Plant And Adjacent Rural Area

Sl. No.	Common Name	Scientific Name	Rural Area	Industrial Area
Family: Pieridae				
Subfamily: Coliadinae				
1	Common Grass Yellow	<i>Eurema hecabe hecabe</i> (Linnaeus, 1758)	+	-
2	One Spot Grass Yellow	<i>Eurema andersoni jordani</i> (Corbet & Pendlebury, 1932)	+	+
3	Common Emigrant	<i>Catopsilia pomona</i> (Fabricius, 1775)	+	-
4	Mottled Emigrant	<i>Catopsilia pyranthe</i> (Linnaeus, 1758)	+	+
Subfamily: Pierinae				
5	Small Salmon Arab	<i>Colotis amata modestus</i> (Butler, 1876)	+	-
6	Striped Albatross	<i>Appias libythea olferna</i> (Swinhoe, 1890)	+	-
7	Indian Cabbage White	<i>Pieris canidia</i> (Linnaeus, 1768)	+	-
8	Common Jezebel	<i>Delias eucharis</i> (Drury, 1773)	+	-
9	Yellow Orange Tip	<i>Ixias pyrene sesia</i> (Fabricius, 1777)	+	-
10	Common Gull	<i>Cepora nerissa evagete</i> (Cramer, 1779)	+	+
11	Common Wanderer	<i>Pareronia valeria hippia</i> (Fabricius, 1787)	+	+
12	Psyche	<i>Leptosia nina nina</i> (Fabricius, 1793)	+	+
Family: Papilionidae				
Subfamily: Papilioninae				
13	Common Mormon	<i>Papilio polytes romulus</i> (Cramer, 1775)	+	+
14	Tailed Jay	<i>Graphium agamemnon menides</i> (Fruhstorfer, 1904)	+	+
15	Lime Butterfly	<i>Papilio demoleus demoleus</i> (Linnaeus, 1758)	+	+
16	Common Jay	<i>Graphium doson eleius</i> (Fruhstorfer, 1907)	-	+
17	Common Mime	<i>Papilio clytia clytia</i> (Linnaeus, 1758)	+	-
18	Common Rose	<i>Pachliopta aristolochiae aristolochiae</i> (Fabricius, 1775)	+	+
Family: Lycaenidae				
Subfamily: Miletinae				
19	Apefly	<i>Spalgis epius epius</i> (Westwood, 1852)	+	-
Subfamily: Curetinae				
20	Indian Sunbeam	<i>Curetis thetis thetis</i> (Drury, 1773)	-	+
Subfamily: Aphnaeinae				
21.	Monkey Puzzle	<i>Rathinda amor</i> (Fabricius, 1775)	+	-
22.	Slate Flash	<i>Rapala manea schistacea</i> (Moore, 1879)	+	-
23.	Common Silverline	<i>Spindasis vulcanus vulcanus</i> (Fabricius, 1775)	+	+
Subfamily: Polyommattinae				
24.	Forget-Me-Not	<i>Catochrysops strabo strabo</i> (Fabricius, 1793)	+	-
25.	Pointed Ciliate Blue	<i>Anthene lycaenina lycaenina</i> (Felder, 1868)	+	-
26.	Gram Blue	<i>Euchrysops cnejus</i> (Fabricius, 1798)	+	-
27.	Plains Cupid	<i>Luthrodes pandava</i> (Horsfield, 1829)	+	-
28.	Quaker	<i>Neopithecops zalmora zalmora</i> (Butler, 1870)	+	-
29.	Dark Grass Blue	<i>Zizeeria karsandra</i> (Moore, 1865)	+	+
30.	Lime Blue	<i>Chilades lajus lajus</i> (Stoll, 1780)	+	-
31.	Tiny Grass Blue	<i>Zizina hylax</i> (Fabricius, 1775)	+	+
32.	Small Cupid	<i>Chilades parrhasius</i> (Fabricius, 1793)	-	+

33.	Ciliate Blue	<i>Anthene emolus emolus</i> (Godart, 1824)	+	-
34.	Pale Grass Blue	<i>Pseudozizeeria maha</i> (Kollar, 1844)	+	+
Subfamily: Theclinae				
35.	Falcate Oakblue	<i>Mahathala ameria</i> (Hewiton, 1862)	+	-
Family: Nymphalidae				
Subfamily: Danainae				
36.	King Crow	<i>Euploea klugii kollari</i> (C. & R. Felder, 1865)	-	+
37.	Double Branded crow	<i>Euploea sylvester</i> (Fabricius, 1793)	+	-
38.	Common Tiger	<i>Danaus genutia genutia</i> (Cramer, 1779)	+	+
39.	White Tiger	<i>Danaus melanippus indicus</i> (Fruhstorfer, 1899)	-	+
40.	Plain Tiger	<i>Danaus chrysipus chrysipus</i> (Linnaeus, 1758)	+	+
41.	Blue Tiger	<i>Tirumala limniace exoticus</i> (Gmelin, 1790)	+	+
42.	Common Crow	<i>Euploeini core core</i> (Cramer, 1780)	+	+
Subfamily: Satyrinae				
43.	Common Palmfly	<i>Elymnias hypermnestra undularis</i> (Drury, 1773)	+	-
44.	Common Bush Brown	<i>Mycalesis perseus</i> (Fabricius, 1775)	+	-
45.	Common Evening Brown	<i>Melanitis leda leda</i> (Linnaeus, 1758)	-	+
46.	Dark Evening Brown	<i>Melanitis phedima bela</i> (Moore, 1857)	-	+
Subfamily: Heliconiinae				
47.	Common Leopard	<i>Phalanta phalantha phalantha</i> (Drury, 1773)	+	+
Subfamily: Acraeinae				
48.	Tawny Coster	<i>Acraea violae</i> (Fabricius, 1793)	+	+
Subfamily: Pyrginae				
49.	Bengal Spotted Flat	<i>Celaenorrhinus putra</i> (Moore, 1866)	+	-
Subfamily: Biblidinae				
50.	Common Castor	<i>Ariadne merione tapestrina</i> (Moore, 1884)	-	+
51.	Angled Castor	<i>Ariadne ariadne indica</i> (Moore, 1884)	+	+
Subfamily: Nymphalinae				
52.	Blue Pansy	<i>Junonia orithya swinhoei</i> (Butler, 1885)	+	-
53.	Great Eggfly	<i>Hypolimnas bolina jacintha</i> (Drury, 1758)	-	+
54.	Lemon Pansy	<i>Junonia lemonias lemonias</i> (Linnaeus, 1758)	-	+
55.	Peacock Pansy	<i>Junonia almanac almana</i> (Linnaeus, 1758)	+	+
56.	Grey Pansy	<i>Junonia atlites atlites</i> (Linnaeus, 1763)	+	+
Family: Hesperidae				
Subfamily: Hesperinae				
57.	Small branded Swift	<i>Pelopidas thrax</i> (Huebner, 1821)	+	+
58.	Rice Swift	<i>Borbo cimara</i> (Wallace, 1866)	+	-
59.	Banana Skipper	<i>Erionota torus</i> (Evaus, 1941)	+	-
60.	Grass Demon	<i>Udaspes folus</i> (Cramer, 1775)	+	-
61.	Common Redeye	<i>Matapa aria</i> (Moore, 1866)	+	-
62.	Dark Palm Dart	<i>Telicota bambusae</i> (Moore, 1878)	+	-
63.	Bush Hopper	<i>Ampittia dioscorides dioscorides</i> (Fabricius, 1793)	+	+
Subfamily: Limenitidinae				
64.	Common Baron	<i>Euthaliaacontheaanagama</i> (Fruhstorfer, 1913)	+	-
65.	Chestnut-streaked Sailer	<i>Neptis jumbah jumbah</i> (Moore, 1858)	-	+
No. of Species			54	35
Sørensen's Index of Similarity			0.54	

Table 2a. Dominance Status Of Species Recorded From Industrial Area.

Sl. No.	Common Name	Scientific Name	Abundance	Relative Abundance (%)	Dominance Status*
Family: Pieridae					
Subfamily: Coliadinae					
1.	One Spot Grass Yellow	<i>Eurema andersoni jordani</i> (Corbet & Pendlebury, 1932)	95	1.19	R
2.	Mottled Emigrant	<i>Catopsilia pyranthe</i> (Linnaeus, 1758)	171	2.14	R
Subfamily: Pierinae					
3.	Common Wanderer	<i>Pareronia valeria hippia</i> (Fabricius, 1787)	59	0.73	SR
4.	Common Gull	<i>Cepora nerissa evagete</i> (Cramer, 1779)	42	0.53	SR
5.	Psyche	<i>Leptosia nina nina</i> (Fabricius, 1793)	117	1.47	R
Family: Papilionidae					
Subfamily: Papilioninae					
6.	Common Rose	<i>Pachliopta aristolochiae aristolochiae</i> (Fabricius, 1775)	360	4.51	SD
7.	Common Mormon	<i>Papilio polytes romulus</i> (Cramer, 1775)	117	1.47	R
8.	Lime Butterfly	<i>Papilio demoleus demoleus</i> (Linnaeus, 1758)	655	8.20	SD
9.	Common Jay	<i>Graphium doson eleius</i> (Fruhstorfer, 1907)	872	10.93	D
10.	Tailed Jay	<i>Graphium agamemnon menides</i> (Fruhstorfer, 1904)	76	0.95	SR
Family: Lycaenidae					
Subfamily: Aphnaeinae					
12.	Common Silverline	<i>Spindasis vulcanus vulcanus</i> (Fabricius, 1775)	92	1.15	R
Subfamily: Curetinae					
11.	Indian Sunbean	<i>Curetis thetis thetis</i> (Drury, 1773)	989	12.39	D
Subfamily: Polyommatainae					
13.	Tiny Grass Blue	<i>Zizina hylax</i> (Fabricius, 1775)	21	0.263	SR

14.	Dark Grass Blue	<i>Zizeeria karsandra</i> (Moore, 1865)	15	0.187	SR
15.	Pale Grass Blue	<i>Pseudozizeeria maha</i> (Kollar, 1844)	05	0.062	SR
16.	Small Cupid	<i>Chilades parrhasius</i> (Fabricius, 1793)	28	0.350	SR
Family: Nymphalidae					
Subfamily: Danainae					
17.	King Crow	<i>Euploea klugii kollari</i> (C. & R. Felder, 1865)	290	3.63	SD
18.	White Tiger	<i>Danaus melanippus indicus</i> (Fruhstorfer, 1899)	901	11.29	D
19.	Common Crow	<i>Euploea core core</i> (Cramer, 1780)	38	0.476	SR
20.	Blue Tiger	<i>Tirumala limniace exoticus</i> (Gmelin, 1790)	803	10.06	SD
21.	Plain Tiger	<i>Danaus chrysippus chrysippus</i> (Linnaeus, 1758)	88	1.102	R
22.	Common Tiger	<i>Danaus genutia genutia</i> (Cramer, 1779)	51	0.639	SR
Subfamily: Satyrinae					
23.	Dark Evening Brown	<i>Melanitis phedima bela</i> (Moore, 1857)	125	1.566	R
24.	Common Evening Brown	<i>Melanitis leda leda</i> (Linnaeus, 1758)	90	1.127	R
Subfamily: Limenitidinae					
25.	Chestnut-streaked Sailer	<i>Neptis jumbah jumbah</i> (Moore, 1858)	950	11.90	D
Subfamily: Heliconiinae					
26.	Common Leopard	<i>Phalanta phalantha phalantha</i> (Drury, 1773)	130	1.629	R
Subfamily: Acraeinae					
27.	Tawny Coster	<i>Acraea violae</i> (Fabricius, 1793)	98	1.228	R
Subfamily: Biblidinae					
28.	Common Castor	<i>Ariadne merione tapestrina</i> (Moore, 1884)	162	2.030	R
29.	Angled Castor	<i>Ariadne ariadne indica</i> (Moore, 1884)	48	0.601	SR
Subfamily: Nymphalinae					
30.	Lemon Pansy	<i>Junonia lemonias lemonias</i> (Linnaeus, 1758)	110	1.378	R
31.	Great Eggfly	<i>Hypolimnas bolina jacintha</i> (Drury, 1758)	162	2.030	R
32.	Peacock Pansy	<i>Junonia almana almana</i> (Linnaeus, 1758)	70	0.877	SR
33.	Grey Pansy	<i>Junonia atlites atlites</i> (Linnaeus, 1763)	59	0.739	SR
Family: Hesperidae					
Subfamily: Hesperinae					
34.	Small branded Swift	<i>Pelopidas thrax</i> (Huebner, 1821)	29	0.363	SR
35.	Bush Hopper	<i>Ampittia dioscorides dioscorides</i> (Fabricius, 1793)	51	0.639	SR

* 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 Area.

Sl. No.	Common Name	Scientific Name	Abundance	Relative Abundance (%)	Dominance Status *
Family: Pieridae					
Subfamily: Coliadinae					
1.	Common Grass Yellow	<i>Eurema hecabe hecabe</i> (Linnaeus, 1758)	213	1.97	R
2.	One Spot Grass Yellow	<i>Eurema andersoni jordani</i> (Corbet & Pendlebury, 1932)	759	7.03	SD
3.	Common Emigrant	<i>Catopsilia pomona</i> (Fabricius, 1775)	160	1.48	R
4.	Mottled Emigrant	<i>Catopsilia pyranthe</i> (Linnaeus, 1758)	268	2.48	R
Subfamily: Pierinae					
5.	Indian Cabbage White	<i>Pieris canidia</i> (Linnaeus, 1768)	81	0.75	SR
6.	Common Jezebel	<i>Delias eucharis</i> (Drury, 1773)	32	0.29	SR
7.	Common Wanderer	<i>Pareronia valeria hippia</i> (Fabricius, 1787)	245	2.26	R
8.	Common Gull	<i>Cepora nerissa evagete</i> (Cramer, 1779)	150	1.38	R
9.	Yellow Orange Tip	<i>Ixias pyrene sesia</i> (Fabricius, 1777)	124	1.14	R
10.	Small Salmon Arab	<i>Colotis amata modestus</i> (Butler, 1876)	30	0.315	SR
11.	Striped Albatross	<i>Appias libythea olferna</i> (Swinhoe, 1890)	155	1.43	R
12.	Psyche	<i>Leptosia nina nina</i> (Fabricius, 1793)	201	1.86	R
Family: Papilionidae					
Subfamily: Papilioninae					
13.	Common Rose	<i>Pachliopta aristolochiae aristolochiae</i> (Fabricius, 1775)	166	1.53	R
14.	Tailed Jay	<i>Graphium Agamemnon menides</i> (Fruhstorfer, 1904)	274	2.53	R
15.	Common Mormon	<i>Papilio polytes romulus</i> (Cramer, 1775)	431	3.99	SD
16.	Lime Butterfly	<i>Papilio demoleus demoleus</i> (Linnaeus, 1758)	482	4.46	SD
17.	Common Mime	<i>Papilio clytia clytia</i> (Linnaeus, 1758)	300	2.77	R
Family: Lycaenidae					
Subfamily: Miletinae					
18.	Apefly	<i>Spalgis epius epius</i> (Westwood, 1852)	111	1.02	R
Subfamily: Aphnaeinae					
19.	Monkey Puzzle	<i>Rathinda amor</i> (Fabricius, 1775)	367	3.40	SD
20.	Common Silverline	<i>Spindasis vulcanus vulcanus</i> (Fabricius, 1775)	441	4.08	SD
21.	Slate Flash	<i>Rapala manea schistacea</i> (Moore, 1879)	138	1.27	R
Subfamily: Polyommatainae					
22.	Gram Blue	<i>Euchrysops cnejus</i> (Fabricius, 1798)	18	0.16	SR
23.	Forget-Me-Not	<i>Catochrysops strabo strabo</i> (Fabricius, 1793)	152	1.40	R
24.	Quaker	<i>Neopithecops zalmora zalmora</i> (Butler, 1870)	320	2.96	R
25.	Tiny Grass Blue	<i>Zizina hylax</i> (Fabricius, 1775)	277	2.56	R
26.	Ciliate Blue	<i>Anthene emolus emolus</i> (Godart, 1824)	101	0.935	SR
27.	Lime Blue	<i>Chilades lajus lajus</i> (Stoll, 1780)	178	1.64	R

28.	Dark Grass Blue	<i>Zizeeria karsandra</i> (Moore, 1865)	119	1.10	R
29.	Plains Cupid	<i>Luthrodes pandava</i> (Horsfield, 1829)	124	1.14	R
30.	Pointed Ciliate Blue	<i>Anthene lycaenina lycaenina</i> (Felder, 1868)	141	1.30	R
31.	Pale Grass Blue	<i>Pseudozizeeria maha</i> (Kollar, 1844)	144	1.33	R
Subfamily: Theclinae					
32.	Falcate Oakblue	<i>Mahathala ameria</i> (Hewiton, 1862)	69	0.639	SR
Family: Nymphalidae					
Subfamily: Danainae					
33.	Common Crow	<i>Euploeini core core</i> (Cramer, 1780)	210	1.94	R
34.	Double Branded crow	<i>Euploea sylvester</i> (Fabricius, 1793)	49	0.453	SR
35.	Plain Tiger	<i>Danaus chrysippus chrysippus</i> (Linnaeus, 1758)	238	2.20	R
36.	Blue Tiger	<i>Tirumala limniace exoticus</i> (Gmelin, 1790)	263	2.43	R
37.	Common Tiger	<i>Danaus genutia genutia</i> (Cramer, 1779)	113	1.04	R
Subfamily: Satyrinae					
38.	Common Bush Brown	<i>Mycalesis perseus</i> (Fabricius, 1775)	46	0.426	SR
39.	Common Palmfly	<i>Elymnias hypermnestra undularis</i> (Drury, 1773)	128	1.18	R
Subfamily: Limenitidinae					
40.	Common Baron	<i>Euthalia aconthea anagama</i> (Fruhstorfer, 1913)	66	0.611	SR
Subfamily: Biblidinae					
41.	Angled Castor	<i>Ariadne ariadne indica</i> (Moore, 1884)	123	1.13	R
Subfamily: Acraeinae					
42.	Tawny Coster	<i>Acraea violae</i> (Fabricius, 1793)	459	4.25	SD
Subfamily: Heliconiinae					
43.	Common Leopard	<i>Phalanta phalantha phalantha</i> (Drury, 1773)	172	1.59	R
Subfamily: Nymphalinae					
44.	Grey Pansy	<i>Junonia atlites atlites</i> (Linnaeus, 1763)	101	0.935	SR
45.	Blue Pansy	<i>Junonia orithya swinhoi</i> (Butler, 1885)	21	0.194	SR
46.	Peacock Pansy	<i>Junonia almanac almana</i> (Linnaeus, 1758)	289	2.67	R
Family: Hesperidae					
Subfamily: Hesperinae					
47.	Grass Demon	<i>Udaspes folus</i> (Cramer, 1775)	272	2.519	R
48.	Common Redeye	<i>Matapa aria</i> (Moore, 1866)	45	0.416	SR
49.	Rice Swift	<i>Borbo cinnara</i> (Wallace, 1866)	595	5.51	SD
50.	Dark Palm Dart	<i>Telicota bambusae</i> (Moore, 1878)	66	0.611	SR
51.	Bush Hopper	<i>Ampittia dioscorides dioscorides</i> (Fabricius, 1793)	383	3.548	SD
52.	Banana Skipper	<i>Erionota torus</i> (Evaus, 1941)	11	0.101	SR
53.	Small branded Swift	<i>Pelopidas thrax</i> (Huebner, 1821)	352	3.261	SD
Subfamily: Pyrginae					
54.	Bengal Spotted Flat	<i>Celaenorhynchus putra</i> (Moore, 1866)	25	0.231	SR

*RA<1 = SUBRECEDENT (SR); 1.1-3.1 = RECEDENT (R); 3.2-10 = SUBDOMINANT (SD); >10.1-31.6 = DOMINANT (D)

Lower number of lepidopteran species in Kolaghat Thermal Power plant area as compared to the adjacent rural area as in the present study was also previously reported by Pahari et al., 2018 who ascribed this to the effect of industrialization at haldia. Jana et al., 2013 recorded 27 species of butterflies from Digha coastal area and Hajra et al., 2015 reported 46 species of butterflies from Contai in Purba Medinipur district. Thus the present study has added to the butterfly fauna of Purba Medinipur district. Lower number of species in Kolaghat Thermal Power plant area might be due to sensitivity of some species to pollutants. Kunte, 2000; Thomas, 2005; Bonebrake et al., 2010 have also suggested that butterfly diversity can be affected by human disturbances like habitat loss and air pollution. 13 species which were exclusively present in the industrial zone may be considered as more tolerant to pollutants and 30 species which were confined to the rural area may be considered as more sensitive to pollutants. Having complex resource utilization pattern, butterflies are more sensitive towards decline ecosystem health (Thomas et al., 2004 and Thomas, 2005).

Any change in native vegetation composition, through anthropogenic interactions, might also be detected by the alteration in species composition of butterflies. Even minor change in habitat may lead to migration or local extinction of native butterflies populations (Blair, 1999; Mennechez et al., 2003). Change in land pattern leading to changes in landscape profile may also lead to change in their diversity (Ghosh and Saha, 2016). In terms of the number of species Nymphalidae was the most common family in Kolaghat Thermal Power plant area with 17 species. This was followed by Lycaenidae (6 species), Pieridae (5 species), Papilionidae (5 species each) and Hesperidae (2 species) respectively (Figure 2a). Preponderance of Nymphalidae was also reported by Tiple and Khurad, 2009 in Nagpur, Majumder et al., 2013 in Tripura, Nair et al., 2014 in Kolkata, Harsh, 2014 in Bhopal, Mondal, 2016 in Chinsurah and Samanta et al., 2017 at Bugmundi hill, Purulia, West Bengal, Khyade and Jagtap, 2017 at Pune and Priya et al., 2017 in a village of Kerala. Pahari et al. 2018 in Haldia Industrial Area. The family Nymphalidae is well adapted, with

its members being polyphagous and capable of thriving in diverse habitats, and species within this family are strong fliers (Majumder et al., 2013). Nymphalidae, therefore is best adapted butterfly family and it dominates in different environmental conditions throughout the country. Pieridae and Hesperidae were less frequent due to their low ecological tolerance and for their preference for relatively less disturbed habitats (Majumder et al., 2013).

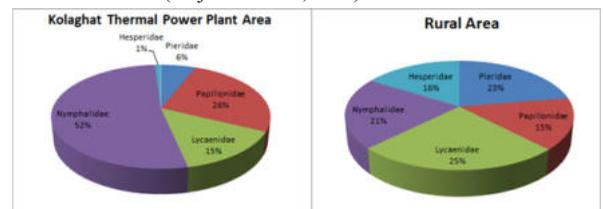


Figure 2a-2b. Family wise percentage of individuals in two sites.

In Rural area, on the contrary, species wise the most dominating family was Lycaenidae with 15 species. It was followed by Nymphalidae (14 species), Pieridae (12 species) and Hesperidae (8 species) respectively. Papilionidae (5 species) in that order preponderance of Lycaenidae and Nymphalidae (Figure 2b) was also reported by Mukherjee et al., 2015 in Kolkata and Pahari et al. 2018 in Haldia Industrial area.

It appears Lycaenidae, Pieridae, Hesperidae prefer relatively undisturbed and less stressed environment as in rural areas. Patil et al., 2014 reported Lycaenidae as second most abundant family. Prabakaran et al., 2014 observed that Hesperidae had maximum number of species in Tamil Nadu.

An analysis of relative abundance revealed that in the Kolaghat Thermal Power plant area 4 species viz., *Graphium dosen eleius*, *Curetis thetis thetis*, *Neptis jumbah jumbah* and *Danaus melanippus*

indicus were dominant, 4 species were subdominant, 13 species were recedent and 14 species were subrecedent in nature (Table 2a). In rural area there was no dominant species but 9 species were subdominant, 30 species were recedent and 15 species were subrecedent (Table 2b). The dominance index (D) was found to be notably lower in the rural zone (0.03) as compared to the industrial zone (0.078) (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 area	Shanon diversity index (H)	Pielou evenness index (J')	Simpson dominance index (D)
Industrial zone	2.89	0.81	0.078
Rural zone	3.71	0.93	0.03

There was little difference in diversity (H) and evenness (J') indices which were relatively higher in the rural area (H = 3.71, J' = 0.93) than Kolaghat Thermal Power plant area (H = 2.89, J' = 0.81) (Table 3). The diversity indices in Kolaghat Thermal Power plant area indicates moderate pollution level which also be supported by the average air quality index (145) by Central Pollution Control Board (National Air Quality index, 2021-2022). Higher diversity in rural belt was also reported by Kitahara and Sei, 2001 in Japan and this was due to agricultural landscape with rural areas which provides habitat heterogeneity and available host plant species (Kuussaari et al., 2007). Relatively higher diversity in the non-industrial rural area than Haldia industrial zone was also reported by Pahari et al., 2018.

In a specific study area, a total of 9 species were identified as being listed in the schedules I, II & IV of the Indian Wildlife (Protection) Act. Specifically, only two species were recorded under Schedule I: *Neptis jumbah jumbah*, observed in the thermal power plant area, and *Papilio clytia clytia*, recorded from the rural area. Similar observations were reported from the Haldia industrial zone by Pahari et al. (2018). However, in the Kolaghat Thermal Power Plant area, two species reported from Haldia-namely the Brown Awl and the Common Banded Awl-were not encountered during the present study.

CONCLUSIONS

Present study revealed that, Kolaghat Thermal Power plant area has less number of butterflies species, lower diversity and evenness indices and higher dominance index as compared to the adjacent rural belt. Findings suggest that Thermal Power plant area offered a relatively harsh environment to butterflies which responded adversely to that predominance of Nymphalidae has also been seen in the Thermal Power plant area. In spite of these the two area 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 area. However, the study suggests that butterflies have the potentiality to be used as good ecological indicator.

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