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Article

Butterfly Diversity across Saraswati-Ganga Plains of Hooghly, West Bengal

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ABSTRACT

Study documents butterfly diversity of suburban and rural stretches of district Hooghly located in southern West Bengal within the Saraswati-Ganga floodplain. Here five habitat patches were considered varying from fruit orchards with closed canopy cover, bamboo forest to open agroecosystem or suburbs with varying anthropogenic activity as study sites during a survey spanning March, 2022 to February, 2024. Overall, 53 butterfly species from five families of Hesperiidae (16.98 %), Papilionidae (15.09 %), Pieriidae (20.75 %), Nymphalidae (28.04 %) and Lycaenidae (16.98 %) were identified. Abundance of butterflies found to be positively correlated with the arrival of monsoon and availability of diverse host plants with relatively low disturbance. Parallel to this a botanical survey records 61 species from 24 families of nectaring and egg-laying host plants. Family Nymphalidae showed broad choice for host plants (14 families) compared to the others. Study also documents the biotope preferences in butterflies and host plant similarities (iso-vegetational similarities) within the habitat patches depending on the species availability.

Introduction

Typically, insects make up more than half of all species on Earth (May 1992) and they are important energy conduits and make up a significant amount of the biomass in all biological systems. (Battist 1988). Any functioning biological communities rely on insects for countless ecological services played as pollinators, predators, preys seed dispersers and herbivores. Among all insects, butterflies are often ranked as the best studied taxonomic groups of insects (Robbins & Opler 1997) and as invaluable flagship species for designing conservation strategies (Thomas 2005). However, butterflies are ecologically most sensitive due to short life cycles (van Swaay and Warren, 1999) and are key indicator of ecosystem health; being the most likely group to reflect changes occurring at a fine scale (van Swaay et al. 2006; Choudhury & Soren 2011). Exponential growth of human population imposing stress to the natural biomes, worldwide. Here butterflies emerge into a sensitive ecosystem indicators of climate change (Sparks et al. 2005; 2007), biotope fragmentation (Warren et al. 2001) and rapid urbanization (Hardy & Dennis, 1999; Jana et al. 2006; Kadlec et al. 2008).

Geographically Hooghly is a flood plain of two major tributaries of Ganga, the Bhagirathi and the Saraswati along with a minor flow of Kunti (Ray & Akhtaruzzaman 2007). The Saraswati was a major river,

but it is mostly died out now. Luxurious alluvium contributes to produce rich natural vegetations and cultivables. Decent resource availability and steady climate favoured human settlement. The economic opportunities created by agriculture, industrialisation, settlements of commercial landmarks led to a huge population influx from neighbouring areas. To be precise; a wide spectrum of land based activities and natural resource extraction due to urbanization leads to habitat loss and destruction of biodiversity (WWF, India Report 2011).

By 1998 there were about 19,238 species of butterflies recorded globally (Heppner 1998) and this figure continues to rise as the newer habitats are explored. As per recent records India hosts about 1,379 species of butterflies (Das et al. 2023) of which peninsular India consists of 350 and the parts of Western Ghat with high endemicity hosts 333 alone (Gaonkar 1996). However, the records of butterflies, in West Bengal, precisely of southern gangetic plain are rudimentary in published documents. To be fair, only very recently the records of butterfly diversity of Kolkata and outskirts surroundings came into light (Chowdhury 2014; Mukherjee 2015). In a similar study, Chowdhury (2010) reported 96 species of butterflies in Chintamoni Kar Bird Sanctuary in southern suburbs near Kolkata and 33 species from Mudialy Nature Park placed in a riverside industrial belts of greater Kolkata (Chowdhury & Chowdhury 2007), 64 species from the Indian Botanic Garden in Howrah near Kolkata (Chowdhury & Das 2007). Except a study by Ghosh & Mukherjee 2016 on Serampore locality of district Hooghly, to date there were no record on the butterfly diversity of the major parts of riverine plains of district Hooghly except some sporadic, unpublished survey attempts by enthusiasts.

Butterflies are mostly phytophagous, rely on the leaves during larval stages and on flowers for nectar in adulthood. Moreover they draw nutrients from soil and animal excreta. Their composition and diversity are intricately linked to plant taxonomic diversity (Mitter et al. 1988). As a strategy, herbivorous butterflies specialize on a set of closely related plants (Ehrlich & Murphy 1988; Ward & Spalding 1993) from where the larvae obtain nutrients required for growth, development and other purposes like display and defence in adulthood (Boppré 1984). The fundamental resources required by the butterflies for successful reproduction comprises a habitat and the larval host plants (Dennis et al. 2003, 2006; Dennis 2010). Knowledge of the exact needs of the larval stages of butterflies and their host plants is a prerequisite for the success of any butterfly conservation programme (New et al. 1995, Kunte 2000). In India, knowledge concerning larval host plants is in rudimentary condition in most parts particularly in the tropics (Kunte 2000). With this observation, we record larval host plant and butterfly diversity across those sampling sites or habitat patches under changing levels of urban influence. The study also reviews seasonal variation in butterfly populations, status and host plant preference to develop comprehensive idea the butterflies of this study zone.

Materials and Methods

Study Sites: The work has been conducted within a radius of 10 km comprising parts (22°56′ to 22°50′30′′ N Latitude 88.20°21′′ to 88°23′ 30.28′′E Longitude) covering Bandel, Chinsurah, Chandernagore and adjacent gram panchayets – Gandhigram and Altara under district Hooghly (**Fig. 1**). The study sites were chosen based on contrasting vegetation types, land-use and levels of disturbance due to human activity (**Table 1**). This part lies amidst of the interfluves of river Ganga to the east, the vanishing course of river Saraswati and the minor flow of river Kunti to the west.

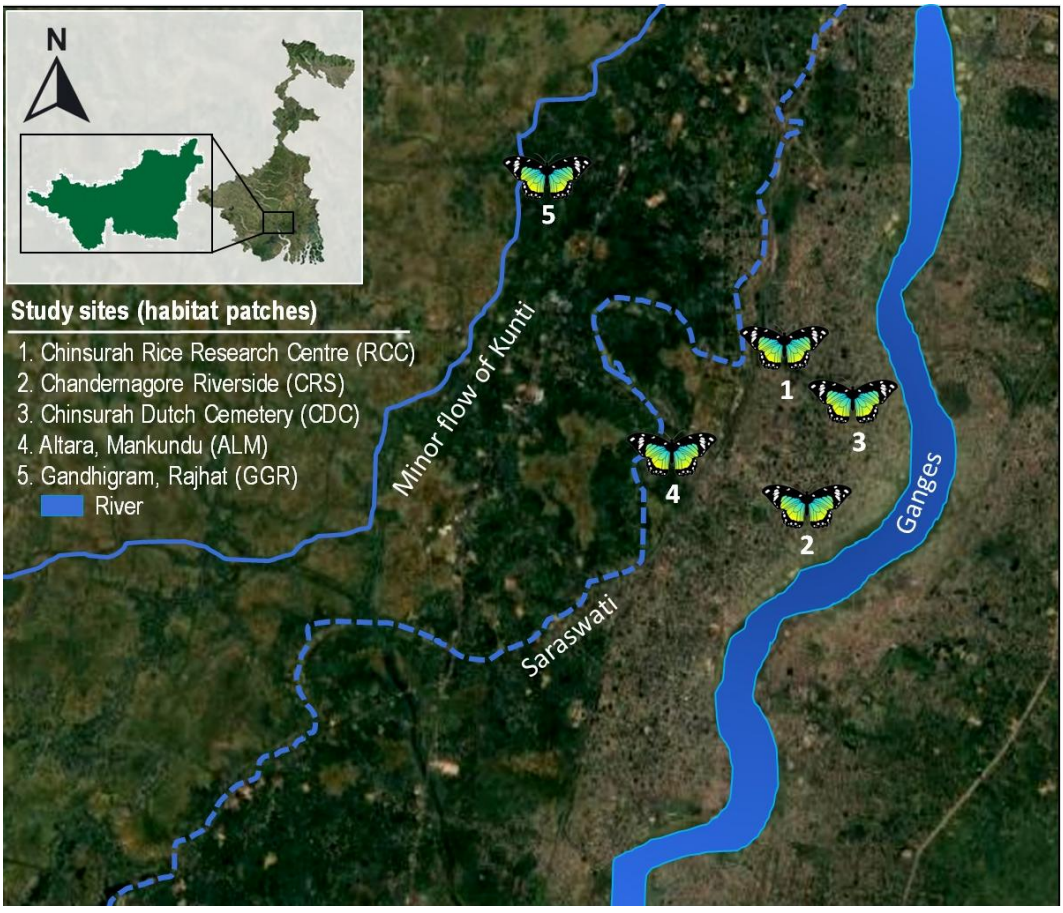

Figure 1 Map showing the distribution of study sites along the Lower Gangetic Plains of Hooghly, West Bengal (Saraswati river course shown in dotted line since it is almost vanished as a water flow).

Table 1: Description of the study sites

Study sites & Area (ha.)	GPS locations & altitude above the sea level	Habitat type & Land use	Urbanization status & Human disturbances
Site 1: Chinsurah Rice Research Centre (RCC) 467.58 ha	22°53′54.9′′ N Latitude & 88°22′10′′ E Longitude; Elevation: 10 m	Government Agricultural Farm; Rice cultivation and experimentation	Urban; very high
Site 2: Chandernagore Riverside (CRS) 262.84 ha	22°51′30′′ N Latitude & 88°22′11′′ E Longitude; Elevation: 17 m	Promenade by the Ganges; Century-old trees along with ornamental plantation, urban activities, moderate to high pollution	Urban; high
Site 3: Chinsurah Dutch Cemetery (CDC) 331.80 ha	22°53′24′′ N Latitude & 88°23′30′′ E Longitude; Elevation: 19 m	Cemetery; Restricted entry, left unused for centuries	Urban; low
Site 4: Altara Amrokunjo (ALM) 523.68 ha	22°50′30′′ N Latitude & 88°19′10′′ E Longitude; Elevation: 12 m	Village; Used for vegetable cultivation, mango plantation and brick production	Nonurban; low

Site 5: Gandhigram, Rajhat (GGR) 248.06	22°56′11′′ N Latitude & 88°20′21′′ E Longitude; Elevation: 16 m	Village; Largely used for vegetable cultivation and mango plantation	Nonurban; very low

Study period: The butterflies were recorded from study sites in three seasonal phases from March 2022 to February 2024. Seasonal survey encompasses the pre-monsoon (March to May), monsoon (June to October), and post-monsoon (November to February). The landscape is characterized by relatively hot and humid monsoonal climate, with an average annual rainfall ranging upto 1,330 mm (mainly recorded in the monsoon) and temperature in summer ranges between 30.4 - 40.2 °C, while in winter varies between 10.2-15.3 °C.

Data Collection: All the butterflies encountered on the line as well as within 5 m on either side were recorded with time and number of individuals seen between 7:00 h and 11:00 h during summer and monsoon and between 7:00 h to 12:00 h in winter when butterflies were out for basking. Seasonality and abundance of butterfly species in different habitats were also recorded. Pollard Walk Method (Pollard 1977; Pollard & Yates 1993) was followed for recording the butterflies while walking along fixed paths in the study areas at a constant pace. Butterfly species were identified directly in the field or, in difficult cases; voucher specimens were collected only with hand-held aerial sweep nets and placed in plastic jars for photography and then freed. Specimen collection was strictly avoided. All scientific names follow Kunte (2000), Kehimkar (2008), Singh (2011) and common English names are after Wynter-Blyth (1957). Classification scheme was followed after Heppner (1998). The observed butterflies from five study sites were grouped in four categories based of sightings in the field - Very Common (VC), Common (C), Not Rare (NR), and Rare (R) (Tiple 2006; 2007).

Identification of larval host and nectar vegetation: The larval host and nectar vegetation were identified from the respective study sites during three seasons of two consecutive years. The occasional presence of butterfly larvae and adults was noted and confirmed from available sources (Tiple et al. 2011; Das et al. 2006; Kehimkar 2010). Those plants that were difficult to identify in the field were photographed and sample specimens were collected as herbarium for consulting with plant taxonomists. Identified and confirmed species were counted within fixed quarters where butterflies and ranked based on their commonness of detection.

Diversity indices analysis:
Species diversity and evenness were calculated using the Shannon index and Pielou's evenness or equitability index (Pielou 1969; Magurran, 1988) respectively.

Rank abundance and cluster analysis: Determining which of the environments supports a greater diversity of butterflies is a challenging but crucial question for conservation management. The number of species and the distribution of those numbers are two crucial aspects of diversity. Even distributions of species are considered to be more diversified by many ecologists (Longino 2000). A rank abundance map uses species abundance to graphically represent diversity. The length of the slope indicates the number of species, while the slope's overall steepness indicates evenness. Therefore, environments with higher species diversity tend to have plentiful species and a uniform slope on a graph. A short, steep line is thought to represent butterflies. Single linkage cluster analysis based on Bray-Curtis similarity was used (using statistical program - Biodiversity Pro version 2.0) to evaluate species composition comparisons between opposing habitats for butterflies (McAleece 1998). (Lambshead et al. 1997) was used for data analysis.

Results

Species composition of the study sites and family-wise distribution: The area shows an assemblage of Fifty-three (53) species of butterflies representing five families (**Table 2, Figure 2**) during this study. The record shows Nymphalids are ahead of other families in total species count at four out of five locations comprising 28 % (GGR), 31 % (CRS and CDC), 33 % (RCC) and Pieridae ahead with 26 % in ALM. Total numbers of species under each family from each site are shown in Fig 2. From the point of view of species richness CDC N=46) and GGR (no. of sp. 43) emerge as best habitats for the butterfly communities followed by ALM (N=38), RCC (N=26) and CRS (N=23). Among the 53 species of butterflies about 32 % (17) were occurring very common (VC), 42 % (22) species were common (C), 13 % (07) were locally common (LC), 4 % (02) were not common (NC) and 9 % (05) were rare (R) (Yamfly, Angled Castor, Striped Blue Crow, Common Palmfly, Common Baron).

Table 2. Systematic List of Butterflies Recorded in Five Study Sites Located within the Alufluve of Ganga-Saraswati River, District Hooghly, West Bengal, India (From Mar. 2022 to Feb. 2024)

Sl. No.	Common Name	Status	Scientific Name	Occurrence	Month-wise Occurrence
Hesperiidae – Total = 09					
1	Chestnut Bob	LC	*Lambrix salsala (Moore, 1866)*	CRS,GGR	3,4,5,8,9,12
2	Grass Demon	LC	*Udaspes folus (Cramer, 1775)*	ALM, GGR	3,4,5,6,7,9,12
3	Common Redeye	LC	*Matapa aria (Moore, 1866)*	CDC, GGR	3,4,5,6,7,8
4	Small Banded Swift	C	*Pelopidas mathias (Fabricius, 1798)*	ALM, RCC, CDC, GGR	2,3,6,8,9,10,11
5	Great Swift	VC	*Pelopidas assamensis (de Nicéville, 1882)*	ALM, RCC, CDC, CRS, GGR	1,3,4,5,6,7,8,9
6	Rice Swift	C	*Borbo cinnara (Wallace, 1866)*	ALM, CDC, CRS, GGR	2,3,4,5,6,7,8,9,10,11, 12
7	Dark Palm Dart	C	*Telicota ancilla (Herrich-Schäffer, 1869)*	CDC, RCC, GGR	1,2,3,5,8,10
8	Pale Palm Dart	LC	*Telicota colon (Fabricius, 1775)*	ALM, GGR, CDC, RCC	3,4,5,6,8,10
9	Common Spotted Flat	C	*Celaenoorrhinus leucocera (Kollar, 1848)*	CDC, RCC, ALM	1,4,5,6
Papilionidae – Total - 08					
10	Common Mormon	VC	*Papilio polytes (Linnaeus, 1758)*	CRS, ALM, CDC, GGR	2,3,5,6,7,10,12
11	Blue Mormon	C	*Papilio polymnester (Cramer, 1775)*	CRS, ALM, CDC	3,5,6,7,8
12	Lime	VC	*Papilio demoleus (Linnaeus, 1758)*	CRS, ALM, CDC, GGR, RCC	1,2,3,5,6,7,8,9,10
13	Common Rose	LC	*Atrophaneura ariastolochiae (Fabricius, 1775)*	ALM, RCC, CDC, GGR	3,4,5,6,7,8,9,10,12
14	Tailed Jay	C	*Graphium agamemnon (Linnaeus, 1758)*	CDC, GGR, ALM	2,4,5,6,7,8,9,10,11,12
15	Common Jay	C	*Graphium doson (Linnaeus, 1758)*	CDC, GGR	4,5,6,7,8,9,10,12
16	Common Mime	VC	*Chilasa clytia (Linnaeus, 1758)*	CRS, ALM, CDC, GGR, RCC	4,5,8,10,11
17	Common banded peacock	LC	*Papilio crino (Fabricius, 1792)*	CDC, GGR	3,4,5,6,7,8
Pieridae – Total - 11					
18	Small Grass Yellow	C	*Eurema brigitta (Cramer, 1780)*	RCC, CDC, GGR	1,3,5,6,7,10,11,12
19	Common Grass Yellow	VC	*Eurema hecabe (Linnaeus, 1758)*	CRS, ALM, RCC, CDC, GGR	1,4,5,6,7,8,9,12
20	Chocolate Grass yellow	C	*Eurema sari (Horsfield,1829)*	CRS, ALM, CDC, GGR	2,5,6,7,8,10,11
21	One Spotted Common Grass Yellow	C	*Eurema andersonii (Moore, 1886)*	CRS, ALM, CDC	1,4,5,6,7,8,9
22	Common Albatross	C	*Appias albino (Boisduval, 1836)*	CRS, ALM, CDC	2,3,4,5,6,7,8,9,10,11, 12
23	Striped Albatross	NC	*Appias libythea (Fabricius, 1775)*	ALM, RCC, CDC	2,4,5,6,7,8,9
24	Common Emigrant	C	*Anapheis aurota (Fabricius, 1775)*	ALM, RCC, CDC, GGR	3,4,5,6,7,8,9,10,12
25	Common Wanderer	C	*Pareronia valeria (Cramer, 1776)*	GGR, ALM	3,4,6,7,12
26	Pioneer	VC	*Belenois aurota (Fabricius, 1775)*	GGR, ALM, CDC	1,4,5,6,7,9,10

27	Common Jezebel	VC	*Delias eucharis (Drury, 1773)*	CRS, ALM, RCC, CDC, GGR	4,5,6,8,9,10
28	Psyche	C	*Leptosia nina (Fabricius, 1793)*	ALM, RCC, GGR	1,4,5,10,11
Lycaenidae – Total - 09					
29	Gram Blue	VC	*Euchrysops cnejus (Fabricius 1798)*	CRS, ALM, RCC, CDC, GGR	1,2,3,4,5,6,7,8,9,10,11,12
30	Lime Blue	C	*Chilades lajus (Cramer 1782)*	CRS, ALM, CDC, GGR	6,7,9
31	Common Pierrot	VC	*Castalius rosimon (Fabricius, 1775)*	ALM, RCC, CDC, GGR	4,5,6,7,8,9,10,11,12
32	Apefly	NC	*Spalgis epius (Westwood, 1851)*	CDC, GGR	1,3,4,9
33	Yamfly	**R**	*Loxura atymnus (Stoll, 1780)*	ALM	1,2,3,4,5,6,7,8,9,10,11
34	Forget-Me-Not	C	*Catochrysops Strabo (Fabricius, 1793)*	CDC, ALM, GGR	2,5,6,7,8,9,10,11,12
35	Chapman's Cupid	C	*Everes argiades (Chapman 1909)*	ALM, GGR	5,6,7,8,9,10,11
36	Common Cerulean	VC	*Jamides celeno (Cramer, 1775)*	CRS, RCC, CDC, GGR	5,6,8,9,10,11,12
37	Common Hedge Blue	VC	*Actolepis puspa (Horsfield, 1828)*	CRS, ALM, RCC, CDC, GGR	1,2,3, 6,7,8,9,10,11
Nymphalidae – Total – 16					
38	Plain Tiger	VC	*Danaus chrysippus (Linnaeus, 1758)*	CRS, ALM, RCC, CDC, GGR	1,3,4,7,8,9,10,11
39	Striped Tiger	C	*Danaus genutia (Cramer, 1779)*	ALM, CDC, GGR	1,2,3,5,7,8,10
40	Blue Tiger	VC	*Tirumala limniace (Cramer, 1775)*	CRS, RCC, CDC, GGR	
41	Angled Castor	**R**	*Ariadne ariadne (Linnaeus, 1758)*	CRS, RCC, CDC, GGR	1,2,4,5,7,8,9,10
42	Common Castor	C	*Ariadne merione (Cramer, 1777)*	CRS, ALM, RCC, CDC, GGR	1,2,3,4,5,6,7,8,9,10,11,12
43	Peacock Pansy	C	*Junonia almanac (Linnaeus, 1758)*	CRS, ALM, RCC, CDC, GGR	4,5,6,8,9,10
44	Grey Pansy	VC	*Junonia atlites (Linnaeus, 1758)*	CRS, ALM, RCC, CDC, GGR	1,2,4,5,7,8,9,10
45	Chocolate Pansy	VC	*Junonia iphita (Linnaeus, 1758)*	ALM, CDC, GGR	2,3,6,7,8,9,10
46	Lemon Pansy	C	*Junonia lemonias (Linnaeus, 1758)*	CDC, GGR	4,6,7,8,9
47	Common Indian Crow	VC	*Euploea core (Cramer, 1780)*	CRS, ALM, RCC, CDC	1,2,3,4,5,6,7,8,9,10,12
48	Striped Blue Crow	**R**	*Euploea mulciber (Cramer, 1777)*	GGR	8,9,10
49	Common Bushbrown	C	*Mycalesis perseus (Fabricius, 1775)*	RCC, CDC	2,3,5,9,10,11
50	Common Four ring	VC	*Ypthima hiiebneri (Kirby, 1871)*	GGR, CDC, RCC, ALM	1,5,6,8,9,10,12
51	Common Palmfly	**R**	*Elymnias hypermnestra (Linnaeus, 1763)*	CDC	1,4,9,10
52	Danaid Eggfly	LC	*Hypolimnus bolina (Linnaeus, 1758)*	ALM, CDC, GGR	3,4,5,8,9,10,12
53	Common Baron	**R**	*Euthalia aconthea (Cramer, 1777)*	CDC	5,8,9

C = Common, LC = Locally common, NC = Not common, R = Rare, VC = Very common; ALM = Altara-Mankundu,
CDC = Chandernagore Dutch Cemetery, CRS = Chandernagore Riverside, GRR = Gandhigram-Rajhat, RCC = Rice Centre-Chinsurah

Figure 2 Photographic evidences of some of the recorded butterflies from the habitat patches located within the Alufluve of Ganga-Saraswati River, Hooghly, West Bengal

Calculations of diversity indices: In this present context the diversity indices were calculated (**Table 3**) which demonstrates that Shannon–Wiener Diversity Index reflects highest values in GGR (1.59) and closely followed by ALM (1.587), CRS (1.568), CDC (1.562) and RCC (1.508). Margalef's Richness Index shows somewhat dissimilar trends as the CRS and RCC score highest richness (1.227 and 1.245 correspondingly) yet having small species number. The study sites are comparable in terms of both evenness and dominance.

Seasonal abundance of butterflies and correlation with monthly rainfall: Month-wise butterfly survey shows highest no. of species was recorded in the mid monsoon (August); a total of 41 species were recorded from the five study sites (**Fig. 3**). The monthly average monthly rainfall (in mm) was recorded from the database of Indian Meteorological Department, Govt. of India. It shows high rainfall as well as high humidity promotes butterfly activities in these areas as reflected in the observation. The butterflies under family Pieridae were high at the onset of

monsoon followed by Nymphalidae in mid and late monsoon. The availability of Hesperiidae gradually drops from pre-monsoon to monsoon showing a differing trend.

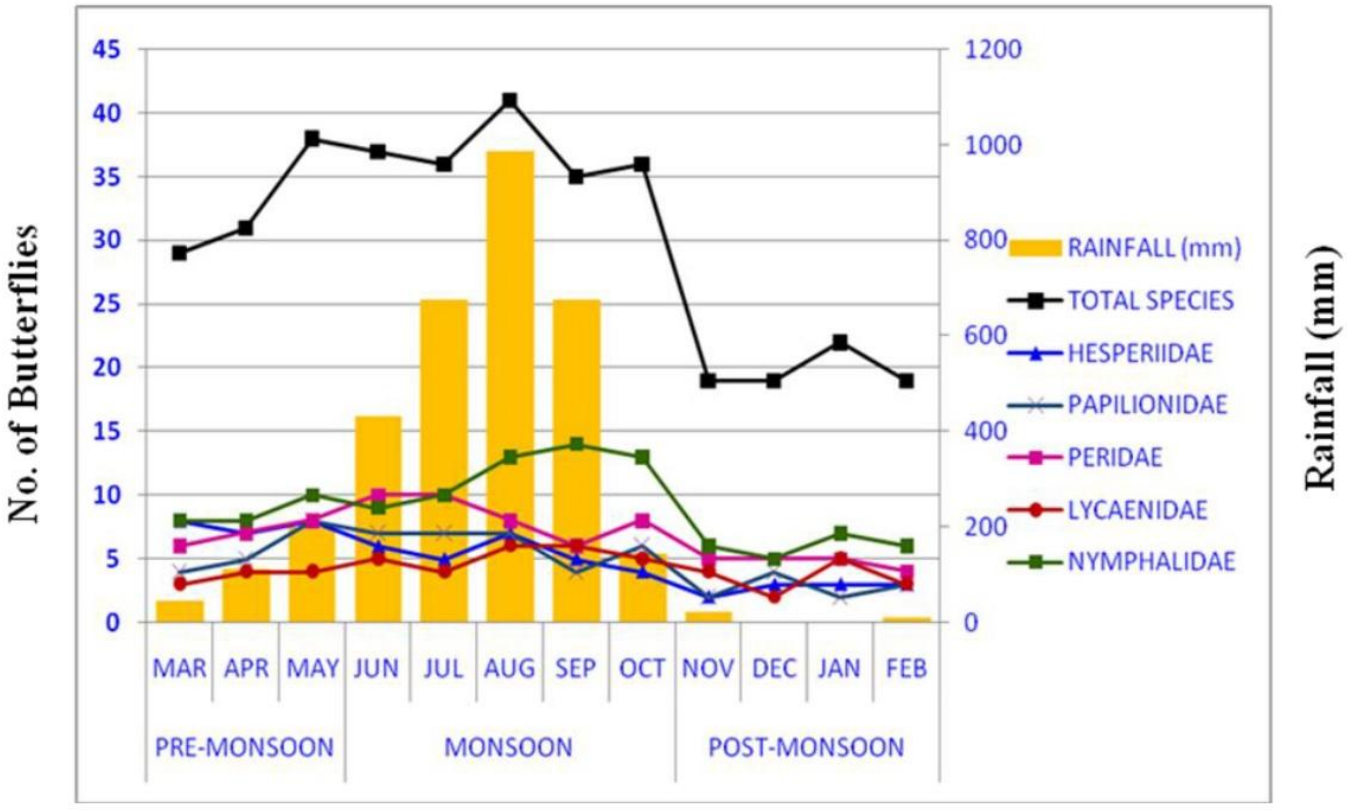

Figure 3 Seasonal abundance of butterflies and families along with local rainfall (mm)

Species diversities for all five sites representing the region were plotted (**Fig. 4**). All sites appear close to each other with GGR being the most diverse with lesser degree of evenness - represented by a long line with a moderately steep slope. CRS, due to the gentle slope, appears to have a high diversity based on evenness; although the closeness of the line reflects the low species richness and a lower overall contribution to total species richness.

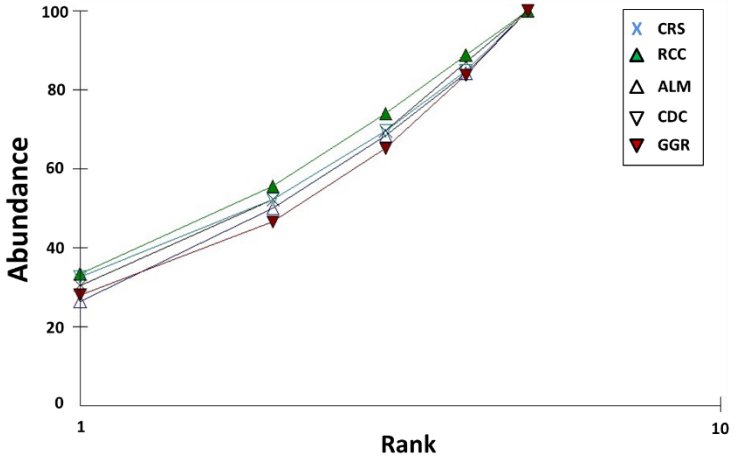

Figure 4 Butterfly species rank-abundance curves for each habitat type (CRS, RCC, ALM, CDC and GGR)

Cluster analysis of similarity of the study sites shows broadly they belong to two separate clusters of habitat. Cluster I, comprised of GGR, CDC and ALM are primarily non-urban, iso-vegetational habitats having 86 % resemblance in terms of species composition, abundance and richness (**Fig. 5**). Moreover, within cluster I GGR and CDC can be further grouped as cluster IA being 91 % similar. Likewise, RCC and CRS, forming cluster II, showed 80 % similarity. The study areas within the two habitat clusters (I & II) showed comparable ecological settings in terms of vegetation types, abundance of water sources, daylight and degree of disturbance. Cluster 1 is characterized by dense covered vegetation, shady and humid patches, frequent water bodies and host plants, fewer man-made disturbances, due to absence of human settlements. Occurrence of sparse vegetation cover, compromised diversity of host plants, and greater man-made disturbances define the cluster II.

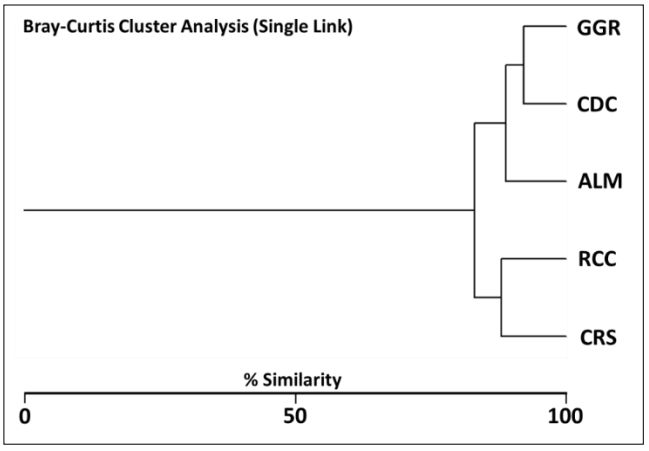

Figure 5 Cluster analysis of similarity of study areas showing two clusters of habitat

Host plant abundance: Butterflies' inclination towards specific habitats is frequently associated with the food sources they consume as larvae or adults. The five butterfly families were found to rely on 61 species of host plants from 24 plant families for leaf content or nectar or both. The vegetation within these study sites primarily comprises 11 species of herbs (grass = 4; climbers = 4) and 27 species of trees 22 species of shrubs. The non-nectar or non-host varieties of vegetation were excluded this record. Among the various plant families Poaceae (7), Acanthaceae, Rutaceae (6), Apocynaceae, Fabaceae (4 each), Annonaceae, Moraceae, Zingiberaceae (3), Asclepidaceae, Arecaceae, Capparaceae, Lauraceae, Malvaceae, Mimosaceae, Rhamnaceae, Verbenaceae (2 each), Anacardiaceae, Aristolochiaceae, Caesalpiniaceae, Euphorbiaceae, Loranthaceae, Magnoliaceae, Myrtaceae Portulacaceae, and Sapindaceae (1 each) were found (**Table 3**). Nymphalids use as many as 14 plant families, followed by Lycaenids 6 and Papilionids 5.

Table 3. Plant species species, associated with butterfly species and their site of occurrence

Host Plant Families & species (Scientific Names)	Habit	Visiting Butterfly species	Butterfly Families	Host Plant Occurrence
Poaceae				
1. *Bambusa arundinaceae*	T	Chestnut Bob, Common Redeye, Dark Palm Dart, Rice Swift	Hesperiidae, Nymphalidae	GGR, ALM, CDC
2. *Oryza sativa*	H	Dark Palm Dart, Rice Swift		RCC, GGR, ALM
3. *Imperata cylindrica*	H	Common Bush Brown, Common Four Ring		GGR
4. *Andropogon spp.*	H	Common Four Ring, Rice Swift		RCC, ALM
5. *Cynodon dactylon*	H	Common Bush Brown		GGR, ALM, CDC, CRS, RCC
6. *Saccharum capsularis*	H	Lemon Pansy, Dark Palm Dart		GGR
7. *Setaria glauca*	H	Rice Swift		ALM, GGR
Fabaceae				
8. *Cassia fistula*	T	Common Grass Yellow	Lycaenidae,	ALM, GGR, CDC

		Mottled Emigrant, Common Emigrant	Pieridae	
9. *Casia tora*	S	Common Grass Yellow Mottled Emigrant, Common Emigrant		CDC, GGR, ALM
10. *Cassia sophera*	S	Common Emigrant		CDC, ALM, GGR
11. *Butea monosperma*	T	Gram Blue, Common Cerulean, Common Emigrant		GGR, CRS, CDC, ALM
Annonaceae				
12. *Annona squamosa*	T	Tailed Jay	Papilionidae	GGR, CDC
13. *Annona reticulate*	T	Tailed Jay		CDC, ALM, CRS, GGR
14. *Polyalthia longifolia*	T	Tailed Jay, Common Jay		GGR, ALM, CDC, CRS, RCC
Rutaceae				
15. *Atlantia racemosa*	T	Common Mormon, Lime Blue	Lycaenidae, Papilionidae	CRS, CDC, GGR
16. *Citrus grandis*	T	Lime, Blue Mormon		GGR, ALM, CRS
17. *Citrus lemon*	S	Lime, Lime Blue, Blue Mormon		CDC, GGR, ALM
18. *Aegle marmelos*	T	Lime, Common Mormon		GGR, ALM, CRS, CDC
19. *Murraya koenigii*	T	Common Mormon, Apefly		GGR, CDC, ALM
20. *Chloroxylon swietenia*	T	Common Banded Peacock		GGR, CDC
Acanthaceae				
21. *Asystacia gangetica*	S	Blue Pansy	Nymphalidae	GGR, CDC, ALM
22. *Hygrophila auriculata*	S	Blue Pansy, Peacock Pansy, Lemon Pansy, Grey Pansy, Chocolate Pansy		GGR, ALM, CDC
23. *Barleria involucrate*	H	Danaid Eggfly, Grey Pansy		GGR, CDC, CRS, ALM
24. *Justicia micrantha*	H	Blue Pansy, Grey Pansy, Chocolate Pansy		GGR, ALM
25. *Acanthus spp.*	S	Peacock Pansy		GGR, CDC, CRS, ALM
26. *Asystacia gangetica*	S	Danaid Eggfly		ALM
Malvaceae				
27. *Hibiscus sp.*	S	Danaid Eggfly, Common Wanderer	Nymphalidae, Pieridae	GGR, ALM, CRS, CDC
28. *Corchorus capsularis*	S	Common Wanderer		GGR, ALM
Moraceae				
29. *Ficus benghalensis*	T	Common Crow	Nymphalidae	GGR, ALM, CDC, CRS, RCC
30. *Ficus racemosa*	T	Common Crow		GGR, ALM, CDC
31. *Ficus religiosa*	T	Common Crow		GGR, CDC, CRS, ALM
Asclepidaceae				
32. *Ceropegia lawii*	S	Plain Tiger, Common Crow	Nymphalidae	GGR, CDC
33. *Asclepias curassavica*	S	Plain Tiger, Blue Tiger, Striped Tiger		GGR, ALM, CDC
Euphorbiaceae				

34. *Ricinus communis*	S	Angled Castor, Apefly	Lycaenidae, Nymphalidae	GGR, ALM, CDC
Arecaceae				
35. *Cocos nocifera*	T	Common Palmfly	Nymphalidae	GGR, ALM, CDC, CRS, RCC
36. *Phoenix spp.*	T	Common Palmfly		CRS, CDC
Zingiberaceae				
37. *Curcuma aromatica*	H	Grass Demon	Hesperiidae	GGR
38. *Curcuma decipiens*	H	Grass Demon		GGR, RCC, CDC
39. *Zingiber spp.*	H	Grass Demon		GGR, ALM, RCC, CDC
Verbenaceae				
40. *Lantana camara*	S	Peacock Pansy	Nymphalidae	GGR, CDC, CRS, ALM
41. *Duranta erecta*	S	Grey Pansy		GGR, CDC, CRS, RCC
Lauraceae				
42. *Litsea chinensis*	T	Lime	Papilionidae	GGR, ALM
43. *Cinnamonum macrocarpum*	T	Common mime		CDC, GGR, ALM
Anacardiaceae				
44. *Mangifera indica*	T	Common Baron	Nymphalidae	GGR, ALM, CRS, CDC, RCC
Magnoliaceae				
45. *Michelia champaka*	T	Tailed Jay, Common Jay	Papilionidae	GGR, CDC, CRS
Aristolochiaceae				
46. *Aristolochia tagala*	H	Common Rose, Crimson Rose	Papilionidae	GGR, ALM, CRS
Portulacaceae				
47. *Portulaca oleracea*	S	Danaid Eggfly	Nymphalidae	ALM, GGR
Myrtaceae				
48. *Callistemon spp.*	T	Common mime	Nymphalidae	ALM
Caesalpiniaceae				
49. *Caesalpinia spp.*	T	Common Cerulean, Common Crow, Common Jezebel	Pieridae Lycaenidae, Nymphalidae	RCC, CDC, CRS, GGR
50. *Saraca asoka*	T	Common Cerulean		CRS, CDC, RCC
Mimosaceae				
51. *Acacia spp.*	T	Common Jezebel	Nymphalidae	GGR, ALM, CRS
52. *Albizzia spp.*	T	Common Jezebel, Blue Tiger		GGR, CRS, CDC
Capparaceae				
53. *Cleome viscosa*	S	Psyche, Striped Albatross	Lycaenidae, Pieridae	CDC, GGR, RCC, ALM
Apocynaceae				
54. *Nerium odorum*	T	Striped Blue Crow, Common Crow	Nymphalidae	CDC, GGR, CRS
55. *Ichnocarpus spp.*	S	Striped Blue Crow		GGR, ALM
56. *Calotropis procera*	S	Blue Tiger, Common Crow		GGR, ALM, RCC, CDC
57. *Calotropis gigantea*	S	Blue Tiger		GGR, ALM, RCC, CDC
Rhamnaceae				
58. *Zizyphus rugosa*	S	Common Pierrot	Lycaenidae	CDC, GGR, ALM
59. *Zizyphus jujube*	S	Common Hedge Blue, Common Pierrot		CDC, GGR, ALM, RCC

Sapindaceae				
60. Schliechera oleosa	T	Forget-me-not, Common Hedge Blue	Lycaenidae	ALM
Loranthaceae				
61. Helicanthus elastica	S	Common Jezebel	Pieridae	CDC, GGR, ALM
T : tree; S = Shrub, H : herb; ALM : Altara-Mankundu, CDC : Chandernagore Dutch Cemetery, CRS : Chandernagore Riverside, GRR : Gandhigram-Rajhat, RCC : Rice Centre-Chinsurah				

Nymphalidae displayed wide choice of host plants (14 families) followed by Lycaenidae (7 families), Peridiidae and Papilionidae (5 families) and Hesperiids confined to 2 families (Poaceae and Zingiberaceae). CRS appeared to be the most densely populated patch which also supports minimum diversity of host plant (only 23 species from 16 families). On contrary, from GGR we record 55 species of host plants under 22 families which found to be the richest patch for butterflies in terms of food source.

Discussion

Literature suggests that human activity causes ecotone effects, expands the number of microhabitats and disturbed flora, and influences butterfly diversity of an area (Devy & Davidar 2001; Padhye et al. 2006). Since butterfly diversity depicts the overall ecosystem health, the study zone – Ganga-Saraswati river interfluve, appears to be an attractive destination for exploring the association with the vegetation types. Originally the study landscape was colonized by different European communities like the French, Dutch, Portuguese, etc. Later on, the area started to get urbanized at a steady pace. The vegetation composition shows moderate to high diversity of mesophytic and semi-xeric plants and among them, many are larval or nectar host plants for butterflies.

During our research work, we have carefully selected five study locations based on both the uniqueness of vegetation assemblages and the nature of anthropogenic disturbances. However, minimal distinction in terms of species occurrence has been found between these study sites as they were closely placed. However occasional variations have been reported in case of host plant availability, contributing to the community-level variations of butterflies. RCC is an institute campus which is majorly an open agro-ecosystem used to grow paddy and a moderate number of shrub species attracts only some of the families of butterflies compared to other sites that are more complex in vegetation structures. Among all the study sites CDC was found to be the most diverse in butterflies perhaps due to its undisturbed nature and pesticide-free vegetation. While GGR, ALM, and CRS support a lesser number of butterfly species. Natural occurrence and seasonal flourish of these host plant resources are essential to help the butterfly population. Alteration in land use patterns by construction works, widening of roadways, replacement of natural vegetation by introducing ornamental alien plant species, unplanned pesticide use, and growing rates of air and soil pollution are the common threats reported from these sites which impact on the species abundance and diversity. Since there was no previous reference to butterfly diversity survey from this riverine floodplain, the authors recommend more follow-up studies in the future. This would determine the temporal trend in butterfly community composition and help to identify the key factors behind such a trend. Purposeful plantation of butterfly host plants can also be recommended based on this study, as a step to boost butterfly species richness.

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