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Avijit Ghosh
Dept. of Zoology (P.G)
Serampore College,
Hooghly, West Bengal, India.
Presently at ICMR Virus Unit
Kolkata, West Bengal, India.

Tanoy Mukherjee
Dept. of Zoology (P.G)
Serampore College,
Hooghly, West Bengal, India.
Presently at Zoological Survey of
India, Kolkata, West Bengal,
India.

Correspondence
Tanoy Mukherjee
Dept. of Zoology (P.G)
Serampore College,
Hooghly, West Bengal, India.
Presently at Zoological Survey of
India, Kolkata, West Bengal,
India.

Butterfly diversity at suburban green patch: A sustainable approach towards conservation

Avijit Ghosh, Tanoy Mukherjee

Abstract
Butterfly diversity at Serampore, West Bengal, India, was studied on the post monsoon season and the habitat includes tree canopy, shrub, herbs, climbers and grasses. Permanent line transect counts were used to record species richness and abundance of butterfly communities. A total of 38 butterfly species belonging to the families of Hesperiidae, Papilionidae, Pieridae, Nymphalidae and Lycaenidae were identified in the present investigation. Quantification of butterfly diversity and species richness was prime objective of this study. This study revealed that even a small natural green patch of a highly populated suburban riverside may hold a high species richness and evenness of butterfly diversity.

Keywords: Butterfly abundance, Serampore (Hooghly), Suburban, Diversity indices, Conservation

1. Introduction
The Indian subcontinent bearing a diverse terrain, climate and vegetation hosts about 1,504 species of butterflies [1]. Butterflies enable sustenance of ecosystem services through their role in pollination and serving as important food chain components. Being potential pollinating agents of their nectar plants as well as indicators of the health and quality of their host plants and the ecosystem as a whole, exploration of butterfly fauna thus becomes important in identifying and preserving potential habitats under threat. Butterflies are potentially useful ecological indicators of urbanization because they can be readily surveyed, and they are sensitive to changes in microclimate, temperature, solar radiation, and the availability of host plants for ovipositing and larval development [2-3]. Increased urban features, including roads, buildings and moved lawns, correspond with decreases in butterfly species richness, diversity and abundance [4-7]. Urbanization also is associated with habitat degradation including decreased plant species diversity, reduced water quality and increased air and soil pollutions [8-12]. Previous studies support the degrading quality and increasing pollution of River Hooghly [13-14]. The reductions in amount and quality of natural habitat associate with urban development negatively affect nature biodiversity [15]. In India pioneering work in butterfly studies dates back to the 19th Century [16-17]. Since, there have been many studies on butterflies from different parts of the India [18-22]. The number of Indian butterflies amount to one fifth of the world of butterfly species [23]. In the recent past, researchers have studied butterflies from some of the urban and sub-urban areas of Kolkata [24-30]. In view of the essential ecosystem services rendered by butterflies and to promote conservation management, the present study was aimed at the estimation of the butterfly diversity across the sub-urban areas of Serampore, Hooghly, India. The results of the study are expected to supplement the necessary information on the ecological roles and conservation management of the butterfly species in Hooghly, India and similar geographical areas

2. Materials and Methods
2.1 Study site
The study site is located at Serampore (22°74′88′′ N and 88° 35′ 46′′ E) and belongs to the suburban belt of Hooghly district of West Bengal, India. The area is just beside River Hooghly and spread over 15.8 acres having tropical shrub and herb vegetation of naturally growing bushy shrubs, herbs, climbers, small grasses and large trees. Good source of nectar, abundance food plants suitable for egg laying, open sunny space, no pesticides and less anthropological disturbance has resulted in varied species diversity of butterflies in the area. Moreover, there are few oxidation ponds and reservoir ponds of Serampore water treatment plant located at

the study site. Various anthropological activities like sporting, fishing, picnic, fuel wood collection by locals, grazing by livestock are common. The place is also famous for its aesthetic value and religious history of old Radhaballav Temple, remnant of which is still present at the study site. The present survey was aimed to prepare a checklist of the butterflies found in Serampore since there are very few known published checklist of butterflies till date.

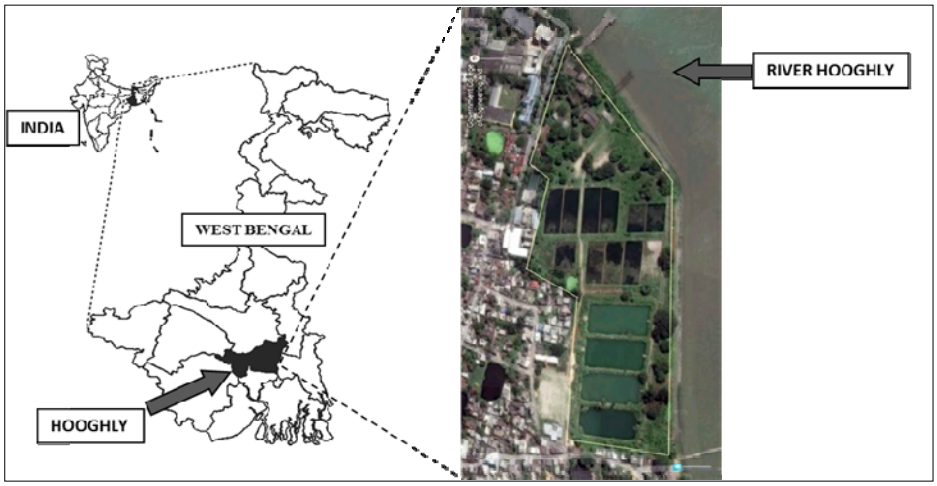

Fig 1: Satellite image of the study site. Location of the site demarked in West Bengal and India.

Fig. 2: Four photographs of the study sites that consist of herbs, shrubs and trees. The first picture shows the remnants of old Radhaballav Temple, one of the sacred places of Serampore region. It may be noted that this type of sacred structure may function as sacred grooves and help immensely in conservation of the study site and related areas of Serampore.

2.2 Sampling

In the present study observations were made during September, 2015-November, 2015 i.e. post monsoon season following Modified Pollard Walk Method [31]. A fixed three transects of 200 m length walked twice a day with 5 m on either side covered in an hour walking at a constant pace between 06:00 hrs and 17:00 hrs. The samplings were done for every 2 days interval and resulted in a final count of 180 transects form study location. All the butterflies on the line as well as 5 m on each side were recorded with respective time and number of individuals seen. Butterfly species were identified directly in the field following photography and identification [23, 32-35]. No capture or collections were made during the present study. Butterflies were photographed from different angles as often as possible to obtain sufficient photographs to enable positive identification of species. The observed butterflies were categorized in five categories on the basis of their abundance in the study site (Table 1): VC-very common (> 100 sightings), C-common (50-100 sightings), NR–not rare (15-50 sightings), R–rare (2-15 sightings), VR-very rare (1-2 sightings) [30-36].

2.3 Statistical analysis

A. Shannon index or H'

Species diversity was calculated using the Shannon Index, which combines the number of species within a site with the

relative abundance of each species [37-40].

$$H' = -\Sigma\, p_i \ln p_i$$

Here, p_i is the proportion of the ith species in the total sample. The number of species (species richness) in the community and their evenness in abundance (or equitability) are the two parameters that define H'.

B. Pielou's Evenness index (Equitability) or J'

The species evenness is the relative abundance or proportion of individuals among the species. Evenness of species reveals how their relative abundance is distributed in a particular sample or site [38-41].

$$J' = H' / \ln S$$

Here, S is the number of species present in the site. The value of J' ranges from 0 to 1. The less variation in communities between the species, the higher the value of J'.

C. Simpson's dominance index or D_s

Species dominance across habitats was estimated by Simpson's dominance index [42]. This index was used to determine the proportion of more common species in a community or an area by the following formula

$$D_s = \Sigma^{s}_{i=1} [n_i (n_i-1)] / [N (N-1)]$$

Where, n_i is the population density of the ith species, and N is the total population density of all component species in the study site.

3. Results and Discussion

During the systematic survey, a total of 3926 sightings consist of Thirty eight species of butterfly belonging to 30 genera and five families were recorded and enlisted in Table 1. Nymphalidae showed the maximum species richness, comprising of 15 species (39%), followed by Lycaenidae (6species, 16%), Pieridae (6 species, 16%), Hesperiidae (6 species, 16%) and Papilionidae (5 species, 13%) as given in Figure 3. Among these species, 1(3%) was very rare, 2 (5%) were rare, 10 (26%) were not rare, 10 (26%) were commonly occurring and 15 (40%) were very common as in Figure 4. Nymphalids are always dominant in the tropical region because their polyphagous nature helps them to live in diverse habitats.

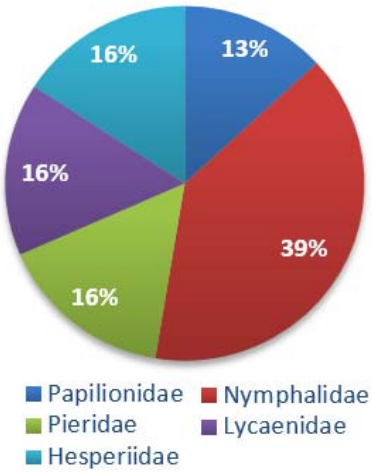

Fig 3: Family-wise composition of butterfly species in study site

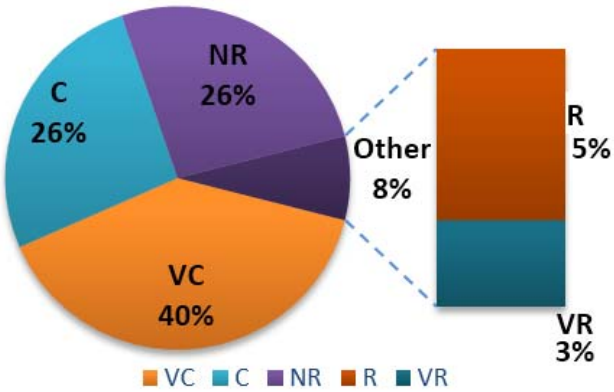

Fig 4: Status of butterfly species at study site

Table 1: Butterfly species, their family and frequency of occurrence

Family	Common Name	Scientific Name	F.O.
Papilionidae	Common mormon	*Papilio polytes*, Linnaeus, 1758	C
	Tailed jay	*Graphium agamemnon*, Linnaeus, 1758	NR
	Lime butterfly	*Papilio demoleus*, Linnaeus, 1758	NR
	Common jay	*Graphium doson*, Felder & Felder, 1864	R
	Blue bottle	*Graphium sarpedon*, Linnaeus, 1758	R
Nymphalidae	Blue pansy	*Junonia orithya*,Linnaeus, 1758	NR
	Common Palmfly	*Elymnias hypermnestra*, Linnaeus, 1763	NR
	Grey pansy	*Junonia atlites*, Linnaeus, 1763	VC
	Lemon pansy	*Junonia lemonias*,Linnaeus, 1758	VC
	Tawny coster	*Acraea terpscore*, Linnaeus, 1758	C
	Great eggfly	*Hypolimnas bolina*, Linnaeus, 1758	NR
	Common crow	*Euploea core*, Cramer, 1780	C
	Plain tiger	*Danaus chrysippus* Linnaeus, 1758	VC
	Common bushbrown	*Mycalesis perseus*, Fabricius, 1775	VC
	Peacock pansy	*Junonia almana*, Linnaeus, 1758	VC
	Blue tiger	*Tirumala limniace*, Cramer, 1775	C
	Common fourring	*Ypthima huebneri*, Kirby, 1871	VC
	Common evening brown	*Melanitis leda*, Linnaeus, 1758	VC
	Angled castor	*Ariadne ariadne*, Linnaeus, 1763	C
	Oriental striped tiger	*Danaus genutia*,Cramer, 1779	NR
Pieridae	Common grass yellow	*Eurema hecabe*, Linnaeus, 1758	VC
	Psyche	*Leptosa nina*, Fabricius, 1793	C
	Indian jezebel	*Delias eucharis*, Drury, 1773	VC
	Eastern striped albatross	*Appias olferna*, Swinhoe, 1890	C

	Mottled emigrant	*Catopsilia pyranthe*, Linnaeus, 1758	VC
	Common emigrant	*Catopsilia Pomona*, Fabricius, 1775	C
Lycaenidae	Common silverline	*Spindasis vulcanus,* Fabricius, 1775	VC
	Common pierrot	*Castalius rosimon,* Fabricius, 1775	VC
	Striped pierrot	*Tarucus nara*, Kollar, 1848	C
	Pale grass blue	*Pseudozizeeria maha*, Kollar, 1848	NR
	Lime blue	*Chilades lajus*, Stoll, 1780	NR
	Common quaker	*Neopithecops zalmora,* Butler, 1870	VC
Hesperiidae	Indian palm bob	*Suastus gremius* Fabricius, 1798	VC
	Indian skipper	*Spialiag alba* Fabricius, 1793	NR
	Dark palm-dart	*Telicota bambusae,* Moore, 1878	VR
	Continental swift	*Parnara ganga,* Evans, 1937	VC
	Bengal obscure branded Swift/Dark branded swift	*Pelopidas agnaagna*, Moore, 1865	C
	* Oriental gram blue	*Euchrysops cnejuscnejus*, Fabricius, 1798	NR

*Listed in Wildlife (Protection) Act Schedule II. VC-Very Common (> 100 sightings), C-Common (50-100 sightings), NR–Not Rare (15-50 sightings), R–Rare (2-15 sightings), VR-Very Rare (1-2 sightings).

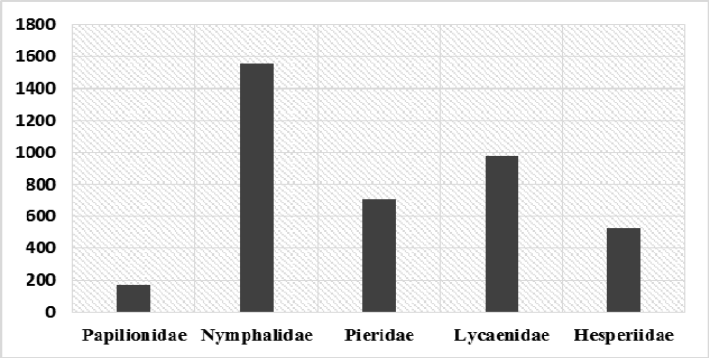

Fig 5. The frequency of occurrence (FO) of each family after whole survey

The frequency of occurrence (FO) of butterflies belonging to five families was estimated and the highest number of individuals (1550) were observed in Nymphalidae followed by Lycaenidae (976), Pieridae (704), Hesperiidae (523) and Papilionidae (173) (Figure 5).

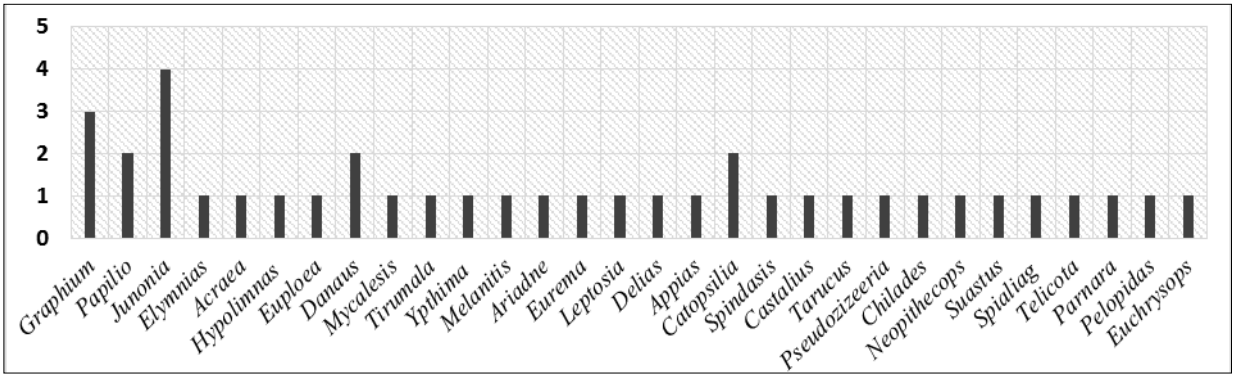

Fig 6: Number of species in each family

Most of the genera were represented by single species but Genus *Junonia* of Nymphalidae includes 4 species, *Graphium* of Papilionidae includes 3, *Papilio* of Papilionidae, *Danaus* of Nymphalidae and *Catopsilia* of Pieridae include 2 (Figure 6).

Particular habitats preference of butterflies is associated with the availability of larval host plants and adult nectar plants. The rich Nymphalid diversity in study area of Serampore indicates a varied assemblage of floral species. The study area is dominated by wild herbs, shrubs and trees namely *Ficus sp., Swietenia sp., Calotropis sp., Tridax sp., Polyalthia longifolia, Lantana camara, Mangifera indica, Zizyphus sp, Sida cordifolia, Apocynum sp., Chromolaena odorata, Parthenium hysterophorus, Euphorbia hirta, Athyrium filix-femina, Datura sp., Ocimum sp., Xanthium sp., Phyllanthus sp., Abutilon indicum, Chrysopogon sp.* and grasses which provide diverse habitat, food and breeding sites for butterflies.

4. Measurement of Biodiversity

Study reveals high species richness and evenness and low dominance at the study area. This is most likely due to suitable micro-environmental conditions and easy availability of host plants. Habitat- Butterflies association of can be directly related to the availability of larval host plants, vegetation cover of herbs, shrubs and trees for nectaring of butterflies [43]. Butterfly in the tropics is highly endemic and diversity is mostly depends on forest vegetation [44-45]. In this present study Shannon Weiner Diversity (H') for all the samples of all 30 genera is 3.288 indicates significant diversity for the sampled area. Pielou's Evenness Index for the study samples is 0.904 which indicates significant evenness therefore no significant disturbance in their habitat. Moreover Simpson's Dominance Index is 0.042 and therefore dominance is at very low level and therefore high evenness.

Fig 7: Pansy Butterflies of Serampore, Hooghly, West Bengal, 1. Grey pansy, *Junonia atlites*, Linnaeus, 1763. 2. Blue pansy, *Junonia orithya*, Linnaeus, 1758. 3. Lemon pansy,*Junonia lemonias*, Linnaeus, 1758. 4. Peacock pansy *Junonia almana*, Linnaeus, 1758. 5. Peacock pansy *Junonia almana*, Linnaeus, 1758. (Dry season form)

Fig 8: Tiger Butterflies of Serampore, Hooghly, West Bengal, 1. Striped Tiger *Danaus genutia* (Cramer, 1779), 2. Plain Tiger *Danaus chrysippus* (Linnaeus, 1758), 3. Blue Tiger *Tirumala limniace* (Cramer, 1775)

Fig 9. Butterflies of *Graphium* genus from Serampore Hooghly, West Bengal, 1. *Graphium doson* 2. *Graphium agamemnon* 3. *Graphium sarpedon*

5. Conclusion

The present study indicates the importance of a small green patch of a suburban area serves as a preferred habitat for butterflies. Though the study site does not offer high economical services still local people does not harm the natural habitat and landscape because of its high recreational and sacred value. If the landscape and the native flora are conserved in a sustainable manner, the diversity of butterflies may increase in the study area providing a rich ground for butterfly conservation as well as for research and ecotourism. Findings of this study will also contribute to future attempts in understanding the complex nature of mutualistic interaction between butterflies and flowering plants that is essential for continuity of ecosystem services. Tough butterfly abundance study have been performed in areas adjacent to Serampore [28], this is one of the pioneering effort in exploring the butterfly diversity at the Serampore region. It may be noted that only a small selected area of Serampore was studied and that too for shorter time span, a more intensive study would surely result in identifying many more species. Detailed studies could be made to improve the list of butterfly species and to ascertain their characteristic distribution in different habitat patches from the present location. The impact of anthropogenic alteration of the habitats in Serampore also needs intensive studies.

6. Acknowledgement

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