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A study on butterfly diversity with their associated host and nectar plants and major threats in the rural parts of the conjugated Egra blocks of Purba Medinipur district, West Bengal, India

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Abstract
The diversity of butterflies (Lepidoptera) with their related host and nectar plants were recorded from the Egra block in Purba Medinipur district of West Bengal. The duration of the work was from June 2019 to August 2019 (3 months) and from March 2020 to November 2020 (9 months) during the lock down period. A total number 80 species of butterflies were found from this block which belongs to 59 genera from five families. Among these, the highest number of species i.e., 26 (32.91%) was recorded from Lycaenidae family in which 11 are legally protected Under the Wildlife (Protection) Act of 1972. From the analysis we found that, the Shannon-Wiener index was 3.272, Shannon Evenness (J') value was 0.751 and the Simpson's index has a value 0.944. During the study, a total number of 54 host plants from 27 families and 77 nectar plants of 29 families were recorded. However, the major threat here is the application of harmful pesticides and herbicides beyond safe limit associated with agriculture, which not only affected the butterfly diversity, but also destroying overall ecosystem of this rural areas.

Keywords: lepidoptera, agriculture, pesticides, herbicides, line transact

Introduction
Butterflies are taxonomically and ecologically best studied group of insects (Robbins & Opler 1997) [38]. They are also excellent environmental indicators due to their sensitivity to habitat loss and climate change (Kunte 2000; Kehimkar 2008) [19]. They help in crop pollination and the evolution of plants contributing an aesthetic value to the environment (Kasambe, 2018) [18]. The diversity of butterflies is reflected in the diversity of plants (Nimbalkar *et al.* 2011) [32]. As a significant portion of the green space, private gardens serve as the food source and refuge for animals (Muratet & Fontaine 2015) [31]. As changes in vegetation have a significant impact on butterfly populations since most butterfly larvae have deep relationships with host plants and adults, require a certain range of nectar plants (Thomas, 1995) [47]. Globally there are about 18000 species of butterflies present and among these. India has about 1500 species alone (Kehimkar, 2008) [19]. But excessive pesticide usage and vegetation removal may hamper butterfly reproduction and affecting population expansion (Tam & Bonebrake 2016) [46]. Pesticides, especially insecticides, are very useful to agriculture widely, but they have also been shown to have negative effects on non-target insects (Braak *et al.* 2018) [4]. Herbicide usage also increases the risk over butterfly populations (Russell & Schultz 2010) [40]. Some other known threats for butterfly habitat decline include climate change and intensified land use over the last few decades (Clark *et al.* 2007) [6].

Materials and Methods
Study Area
The Purba Medinipur district is located in the lower Gangetic and eastern coastal plains (Dwari & Mondal 2020) [9]. The temperature in this region ranges from 30ºC to 38ºC during the summer (March-June) and from 15ºC to 25ºC during the winter (November-February) (Payra *et al.* 2017) [35]. The average annual rainfall in this district is around 1700mm (Payra *et al.* 2017; Dwari & Mondal 2020) [35, 9]. There are four sub-division namely Tamluk, Haldia, Contai and Egra in this district, where the Egra Sub-division consists of two blocks - Egra-I and Egra-II. According to geomorphology, this region is a part of "Digha-Kanthi coastal plains" of West Bengal's lower coastal tract. On the other hand, this area is the lower part of Rasulpur River, within the "Dubda basin" (Karan *et al.* 2015) [17].

The study was focused on the rural parts of two Egra blocks of Purba Medinipur district. A total of twelve locations from twelve villages were selected from these two blocks for our study,which were Harichak (21° 54' 19" N, 87° 33'58"E), Erendabar (21° 54' 52" N, 87° 34'11"E), Adlabad (21° 53' 52" N, 87° 33'19"E), Hosenpur (21° 53' 17" N, 87° 32' 26"E) from Egra-I; and Nayapara (21° 52' 49" N, 87° 35'5"E), Krishnapur (21° 53' 14" N, 87° 35'42"E), Khejurda(21° 53' 2" N, 87° 34'14"E), Rukminipur (21° 53' 38" N, 87° 34'44"E), Nankrar hatida (21° 53' 57" N, 87° 35'1"E) Saharda (21° 54' 30" N, 87° 34'49"E), Sultanpur (21° 54' 30" N, 87° 34'33"E), Chandanpur (21° 54' 23" N, 87° 34'58"E) from Egra-II. The habitats of these study areas are mostly vast agricultural fields with few patches of scattered trees and bushes surrounding them where the major cultivated crops are paddy, ground nuts, betel leaf, mustard and vegetables, along with few small forested areas with private gardens, village woodlands, and bamboo thickets, roadsides, pond banks and crematorium areas.

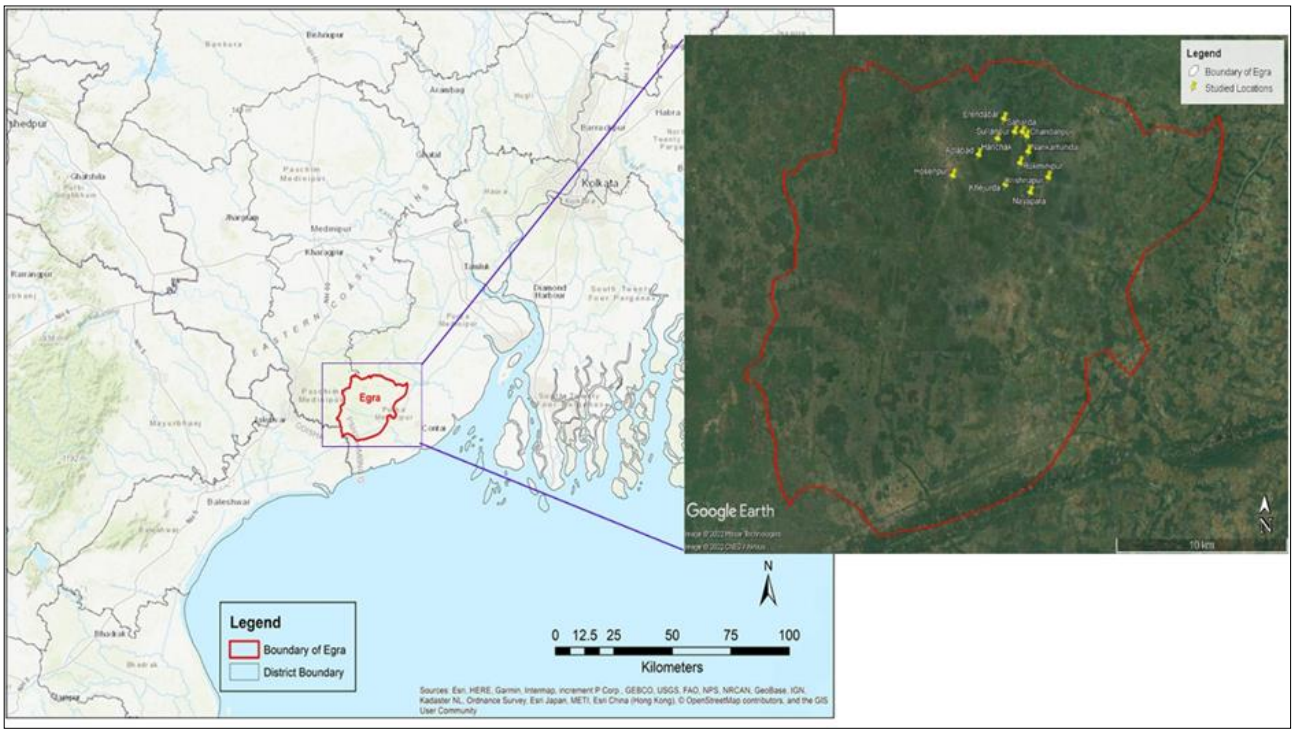

Fig 1: Map of the undivided Egra block (not accurate) of Purba Medinipur district with the visited locations.

The study was done from June 2019 to August 2019 (3 months) and during the lock down period from March 2020 to November 2020 (9 months) where each of these villages were visited oneday per month. Data was collected from 8.30 am to 11.30 am regularly with few occasional surveys in the early morning and late afternoon looking for butterflies those prefer shadows or in shelter (Biswas *et al*. 2019) [3]. Basically, we followed the Line transacts method, but where not possible applied visual encounter method and opportunistic survey. The regular samplings were recorded following an interval of 30 minutes for the line transects method. The starting points and directions of transacts were randomly chosen because the length of the tracks frequently varied due to topographical obstructions like impenetrable bushes, roads and waterbodies that limited the access (Hossain & Aditya 2014) [15]. Butterflies along with their host and nectar plants were photographed using Nikon Coolpix B700 (Resolution: 20MP, Zoom: 60x) and smartphone camera. Based on their presence in the study area, the observed butterfly species were classified into five groups, *viz.* VC - very common (more than 100 sightings), C - common (between 50-100 sightings), NR - not rare (between 15-50 sightings), R - rare (between 2-15 sightings), VR - very rare (not more than 1–2 sightings) (Tiple *et al*. 2007; Payra *et al*. 2017) [49, 35]. Scheduled category according to Indian Wildlife (Protection) Act (WPA), 1972 also been listed along with the species identity. For the identification, field guides and books like "The book of Indian Butterflies" (Kehimkar, 2008) [19], "Butterflies of Western Ghats" (Kasambe, 2018) [18] were followed. Additional support was obtained from www.ifoundbutterflies.org [22]. A public survey was conducted among the farmers to identify the herbicides and insecticides they apply in agricultural fields and other areas.

Data Analysis

Data were analysed by using Microsoft Excel. The Shannon index (Shannon & Weaver 1949) [42] was used to assess species richness. This is a useful information for statistical index for determining the species richness of a community. Rare species with very few individuals can add significant value to a biodiversity index. The index is calculated using the following equation:

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

Where, H' is the Shannon-Wiener index of species diversity, P_i is the proportion of each species in the community and $\ln P_i$ is the natural logarithm of P_i.

Evenness Index (Magurran, 2021) [27] is the measurement of the relative abundance of various species within a given area. Species evenness will be greater if all species are equally distributed in an area.

Measurement of Shannon's evenness index was calculated using the following formula:

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

Where, H′ is the Shannon Index and S is the total number of species in habitats.

While the Simpson index (Simpson, 1964) [44] was used to assess species abundance. This index is the measure of the probability that two individuals randomly selected from a community will belong to the same species. Simpson's index was calculated using this formula:

$$D = 1-\{\sum n\,(n-1)/N\,(N-1)\}$$

Where, 'n' is the number of individuals of single species and 'N' is the total number of all individuals.

Ranges of this index is 0 to 1. Where '0' is complete uniformity and '1' is complete diversity.

Results

A total number of 9,458 individuals recorded during this study which belongs from 80 species of butterflies covering

59 genera, and five families (Table 1). Lycaenidae was the highest family with 26 (32.91%) species followed by Nymphalidae 24 (30.37%), Pieridae 12 (15.18%), Papilionidae 9 (11.39%) and Hesperiidae 9 (11.39%). According to the assessment of local abundance, 24 (30%) species were very common, 8 (10%) species were common, 11 (13.75%) species were not rare, 23(28.75%) species were rare, and 14 (17.5%) species were very rare. And among those identified butterflies, 11 were legally protected under the Wildlife (Protection) Act of 1972 [25].

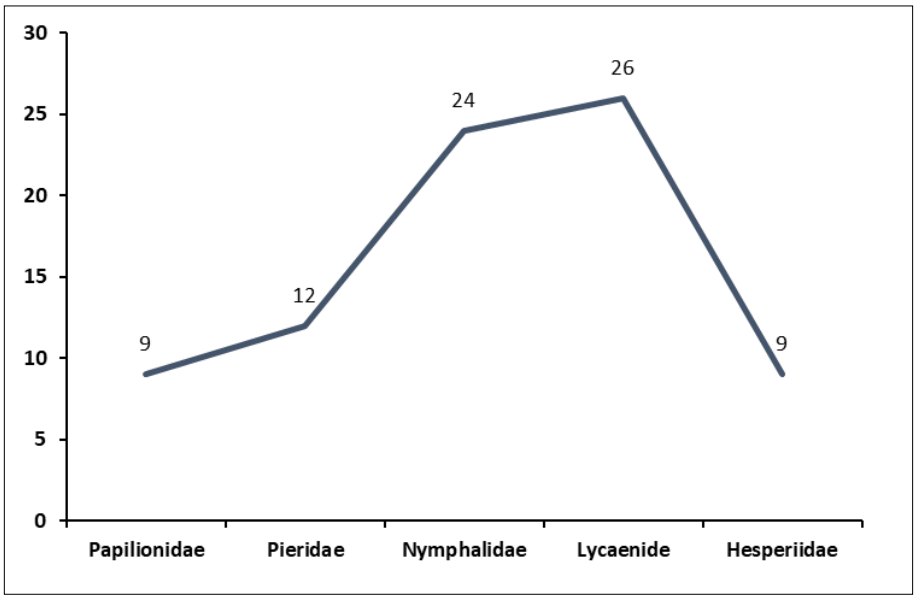

Fig 2: Family-wise distribution of recorded butterflies.

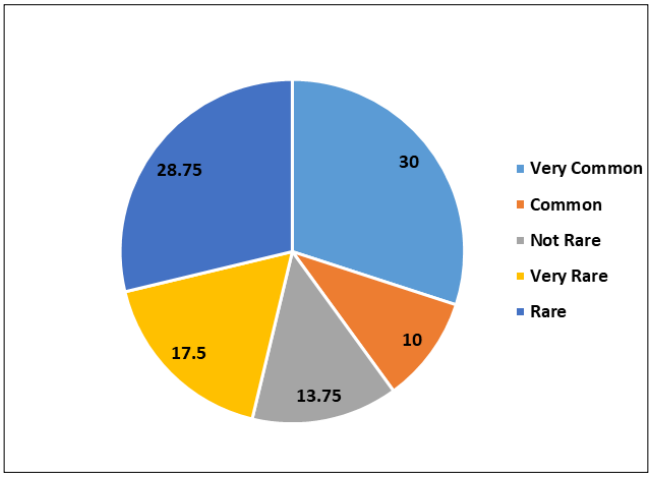

Fig 3: Percentage of their abundance.

Table 1: Checklist of butterflies from Egra block, Purba Medinipur.

Sl. No.	Common Name	Scientific Name	WPA 1972	Status
Family: Papilionidae (9)				
1	Common Jay	*Graphium doson*(C. & R. Felder, 1864)	No	R
2	Tailed Jay	*Graphium agamemnon*(Linnaeus, 1758)	No	NR
3	Blue Mormon	*Papilio polymnestor* (Cramer, 1775)	No	C
4	Common Mormon	*Papilio polytes* Linnaeus, 1758	No	VC
5	Lime Swallowtail	*Papilio demoleus* Linnaeus, 1758	No	VC
6	Common Rose	*Pachliopta aristolochiae* (Fabricius, 1775)	No	NR
7	Crimson Rose	*Pachliopta hector*Linnaeus, 1758	WPA-I	R
8	Common Mime	*Papilio clytia* Linnaeus, 1758	No	C
9	Common Banded Peacock	*Papilio crino* Fabricius, 1793	No	VR
Family: Pieridae (12)				
10	Common Gull	*Cepora nerissa* (Fabricius, 1775)	No	VC
11	Indian Jezebel	*Delias eucharis* (Drury, 1773)	No	NR
12	Painted Jezebel	*Delias hyparete* (Linnaeus, 1758)	No	R
13	Eastern Striped Albatross	*Appias olferna* Swinhoe, 1890	No	VC
14	Psyche	*Leptosia nina* (Fabricius, 1793)	No	VC
15	Indian Wanderer	*Pareronia hippia* (Fabricius, 1787)	No	VC

16	Lemon Emigrant	*Catopsilia pomona* (Fabricius, 1775)	No	VC
17	Mottled Emigrant	*Catopsilia pyranthe* (Linnaeus, 1758)	No	VC
18	Common Grass Yellow	*Eurema hecabe* (Linnaeus, 1758)	No	VC
19	Small Grass Yellow	*Eurema brigitta*(Stoll, [1780])	No	R
20	Yellow Orange-tip	*Ixias pyrene* (Linnaeus, 1764)	No	VC
21	Small Salmon Arab	*Colotis amata* (Fabricius, 1775)	No	NR
FAMILY: NYMPHALIDAE(24)				
22	Plain Tiger	*Danaus chrysippus*(Linnaeus, 1758)	No	VC
23	Striped Tiger	*Danaus genutia* (Cramer, [1779])	WPA-I	C
24	Common Crow	*Euploea core* (Cramer, [1780])	No	VC
25	King Crow	*Euploea klugii* (Moore, [1858])	WPA-IV	C
26	Common Evening Brown	(Linnaeus, 1758)	No	NR
27	Common Bushbrown	*Mycalesis perseus* (Fabricius, 1775)	No	VR
28	Common Palmfly	*Elymnias hypermnestra*(Linnaeus, 1763)	No	C
29	Angled Castor	*Ariadne ariadne* (Linnaeus, 1763)	No	VC
30	Common leopard	*Phalanta phalantha*(Drury, [1773])	No	NR
31	Grey Pansy	*Junonia atlites* (Linnaeus, 1763)	No	VC
32	Lemon Pansy	*Junonia lemonias* (Linnaeus, 1758)	No	VC
33	Peacock Pansy	*Junonia almana* (Linnaeus, 1758)	No	VC
34	Chocolate Pansy	*Junonia iphita* (Cramer, [1779])	No	VR
35	Blue Pansy	*Junonia orithya* (Linnaeus, 1758)	No	VR
36	Black Rajah	*Charaxes solon* (Fabricius, 1793)	WPA-II	R
37	Common Baron	*Euthalia aconthea* (Cramer, [1777])	No	C
38	Chestnut-streaked Sailer	*Neptis jumbah* (Moore, 1858)	No	NR
39	Common Duffer	*Discophora sondaica* Boisduval, 1836	WPA-I	R
40	Painted Lady	*Vanessa cardui* (Linnaeus, 1758)	No	VR
41	Blue Tiger	*Tirumala limniace* (Cramer, [1775])	No	VC
42	Oriental Great Eggfly	*Hypolimnas bolina* (Linnaeus, 1758)	No	NR
43	Danaid Eggfly	*Hypolimnas misippus*(Linnaeus, 1764)	WPA-II	VR
44	Commander	*Moduza procris* (Cramer, [1777])	No	R
45	Tawny Coster	*Acraea terpsicore* (Linnaeus, 1758)	No	R
FAMILY: LYCAENIDAE(26)				
46	Common Cerulean	*Jamides celeno* (Cramer, [1775])	No	VC
47	Dark Cerulean	*Jamides bochus* (Stoll, [1782])	No	R
48	Forget-me-not	*Catochrysops strabo* (Fabricius, 1793)	No	R
49	Zebra Blue	*Leptotes plinius* (Fabricius, 1793)	No	R
50	Silverstreak Blue	*Iraota timoleon* (Stoll, [1790])	No	VR
51	Common Pierrot	*Castalius rosimon* (Fabricius, 1775)	**No**	R
52	Dark Grass Blue	*Zizeeria karsandra* (Moore, 1865)	No	R
53	Pale Grass Blue	*Pseudozizeeria maha* (Kollar, [1844])	No	VC
54	Lesser Grass Blue	*Zizina otis* (Fabricius, 1787)	No	R
55	Tiny Grass Blue	*Zizula hylax* (Fabricius, 1775)	No	VC
56	Common Quaker	*Neopithecops zalmora* (Butler, [1870])	No	VC
57	Gram Blue	*Euchrysops cnejus* (Fabricius, 1798)	WPA-II	VC
58	Pea Blue	*Lampides boeticus* (Linnaeus, 1767)	WPA-II	R
59	Lime Blues	*Chilades lajus* (Stoll, [1780])	No	VC
60	Slate Flash	*Rapala manea* (Hewitson, 1863)	No	R
61	Apefly	*Spalgis epius* (Westwood, [1851])	No	VR
62	Purple Leaf Blue	*Amblypodia anita* Hewitson, 1862	No	R
63	Common Guava Blue	*Virachola isocrates* (Fabricius, 1793)	WPA-II	VR
64	Common Ciliate Blue	*Anthene emolus* (Godart, [1824])	No	VR
65	Pointed Ciliate Blue	*Anthene lycaenina* (R. Felder, 1868)	WPA-II	R
66	Common Lineblue	*Prosotas nora* (C. Felder, 1860)	No	NR
67	Tailless Lineblue	*Prosotas dubiosa* (Semper, [1879])	No	R
68	Plains Cupid	*Chilades pandava* (Horsfield, [1829])	No	C
69	Indian Sunbeam	*Curetis thetis* (Drury, [1773])	No	R
70	Broad-tail Royal	*Creon cleobis* (Godart, [1824])	No	VR
71	Common Silverline	*Spindasis vulcanus* (Fabricius, 1775)	No	VR
FAMILY: HESPERIIDAE(9)				
72	Swift	*Parnara sp.*	No	C
73	Common Branded Redeye	*Matapa aria* (Moore, [1866])	No	NR
74	Palm Dart	*Telicota sp.*	No	NR
75	Common Banded Awl	*Hasora chromus* (Cramer, [1780])	No	R
76	Brown Awl	*Badamia exclamationis* (Fabricius, 1775)	No	VR
77	Common Snow Flat	*Tagiades japetus* (Stoll,1781)	WPA-II	VR
78	Grass Demon	*Udaspes folus* (Cramer, [1775])	No	VC
79	Oriental Palm Bob	*Suastus gremius* (Fabricius, 1798)	No	R
80	Rounded Palm Redeye	*Erionota torus* (Linnaeus, 1767)	No	R

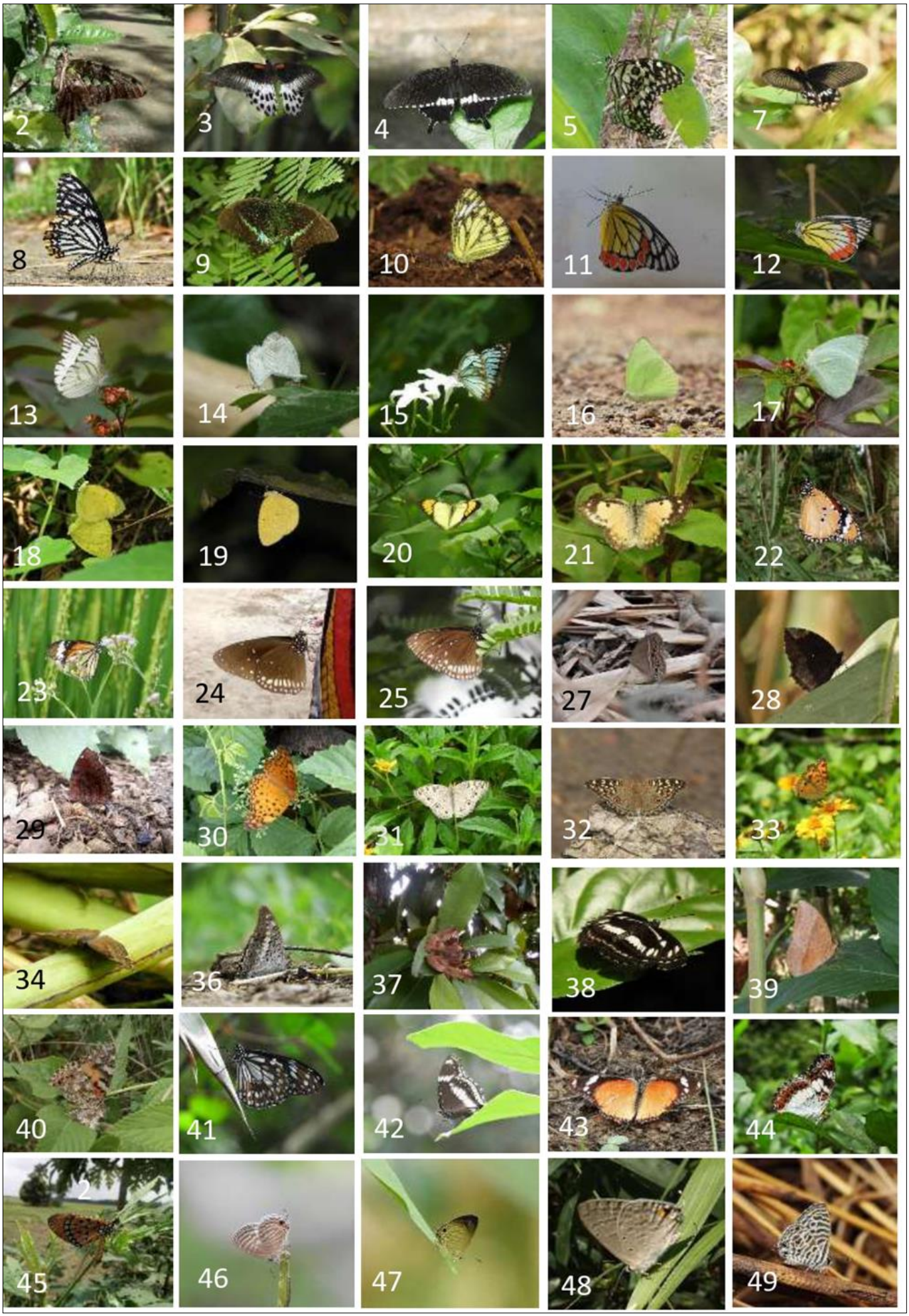
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Fig 4: Photographs are numbered following the serial number of Table 1.

The Shannon-Wiener index 3.272 indicates that this area has high species richness. The Shannon Evenness (J') value 0.751 indicates high diversity and low dominance in this community. The Simpson's index was 0.944 (close to 1) means complete diversity.

As majority of herbivorous insects also dependent on one or more host plant species, increased plant diversity will help increase their diversity too (Knops, 1999) [21]. Thus the host preferences and strategies of these host plants, in turn, have significant and substantial impacts on population characteristics and geography (Dennis *et al*. 2004)[8]. During the study of total of 54 host plants, sharing 27 families were observed including herbs, shrubs, trees and climbers (Table 2). The relation of butterflies with their host plants were gathered by direct observation and from ifoundbutterflies.org [22].

Table 2: List of host plants with associated butterflies from the study area.

Sl. No.	Family	Scientific Name	Dependent Butterflies
1	Acanthaceae	*Hygrophila auriculata*	Peacock Pansy (*Junonia almana*), Grey Pansy (*Junonia atlites*), Lemon Pansy (*Junonia lemonias*), Blue Pansy (*Junonia orithya*), Tiny Grass Blue (*Zizula hylax*)
2		*Ruellia tuberosa*	Tiny Grass Blue (Zizula hylax)
3	Amaranthaceae	*Amaranthus spinosus*	Dark Grass Blue (*Zizeeria karsandra*)
4	Anacardiaceae	*Mangifera indica*	Common Baron (*Euthalia aconthea*)
5	Annonaceae	*Polyalthia longifolia*	Common Jay (*Graphium doson*), Tailed Jay (*Graphium agamemnon*)
6		*Polyalthia Suberosa*	Common Jay (*Graphium doson*), Tailed Jay (*Graphium agamemnon*)

7	Apocynaceae	*Wattakaka volubilis*	Blue Tiger (*Tirumala limniace*)
8		*Calotropis gigantea*	Plain Tiger (*Danaus chrysippus*), Striped Tiger (*Danaus genutia*)
9		*Cascabela thevetia*	Common Crow (*Euploea core*)
10		*Hemidesmus indicus*	Common Crow (*Euploea core*)
11	Arecaceae	*Phoenix sylvestris*	Common Palmfly (*Elymnias hypermnestra*), Oriental Palm Bob (*Suastus gremius*)
12		*Borassus flabellifer*	Common Palmfly (*Elymnias hypermnestra*), Oriental Palm Bob (*Suastus gremius*)
13		*Calamus* sp.	Common Palmfly(*Elymnias hypermnestra*), Oriental Palm Bob (*Suastus gremius*)
14		*Cocos nucifera*	Common Palmfly (*Elymnias hypermnestra*), Oriental Palm Bob (*Suastus gremius*)
15	Aristolochiaceae	*Aristolochia indica*	Common Rose (*Pachliopta aristolochiae*), Crimson Rose (*Pachliopta hector*)
16	Capparaceae	*Capparis zeylanica*	Common Gull (*Cepora nerissa*), Indian Wanderer (*Pareronia hippia*), Psyche (Leptosia nina)
17		*Cleome viscosa*	Psyche (*Leptosia nina*)
18		*Crateva religiosa*	Eastern Striped Albatross (*Appias olferna*)
19	Combretaceae	*Combretum indicum*	Slate Flash (*Rapala manea*)
20	Euphorbiaceae	*Tragia involucrata*	Angled Castor (*Ariadne ariadne*)
21	Fabaceae	*Millettia pinnata*	Common Cerulean (*Jamides celeno*), Dark Cerulean (*Jamides bochus*), Indian Sunbeam (*Curetis thetis*), Common Banded Awl (*Hasora chromus*), Forget-me-not (*Catochrysops strabo*)
22		*Senna occidentalis*	Lemon Emigrant (*Catopsilia pomona*), Mottled Emigrant (*Catopsilia pyranthe*)
23		*Sesbania bispinosa*	Common Grass Yellow (*Eurema hecabe*), Mottled Emigrant (*Catopsilia pyranthe*), Zebra Blue(*Leptotes plinius*), Lesser Grass Blue(*Zizina otis*)
24		*Tamarindus indica*	Black Rajah (Charaxes solon)
25		*Cassia fistula*	Lemon Emigrant (*Catopsilia pomona*), Mottled Emigrant (*Catopsilia pyranthe*), Common Grass Yellow (*Eurema hecabe*)
26		*Vigna unguiculata*	Pea Blue (*Lampides boeticus*)
27		*Senna alata*	Mottled Emigrant (*Catopsilia pyranthe*), Common Grass Yellow (*Eurema hecabe*)
28		*Mimosa pudica*	Common Grass Yellow (*Eurema hecabe*), Tailless Lineblue (*Prosotas dubiosa*)
29	Flacourtiaceae	*Flacourtia indica*	Common Leopard (*Phalanta phalantha*)
30	Lamiaceae	*Clerodendrum infortunatum*	Slate Flash (*Rapala manea*)
31	Lauraceae	*Litsea deccanensis*	Common Mime (Papilio clytia)
32		*Cinnamomum tamala*	Common Mime (*Papilio clytia*)
33	Loranthaceae	*Dendrophthoe falcata*	Indian Jezebel (*Delias eucharis*)
34	Meliaceae	*Azadirachta indica*	Indian Jezebel (*Delias eucharis*)
35	Moraceae	*Streblus asper*	King Crow (*Euploea klugii*), Common Crow (*Euploea core*), Common Baron (*Euthalia aconthea*)
36		*Ficus racemosa*	Common Crow (*Euploea core*), Silverstreak Blue *Iraota timoleon*)
37		*Ficus hispida*	King Crow (*Euploea klugii*)
38		*Ficus benghalensis*	Silverstreak Blue (*Iraota timoleon*), Common Crow (*Euploea core*)
39	Musaceae	*Musa sp.*	Rounded Palm-redeye (*Erionota torus*)
40	Myrtaceae	*Psidium guajava*	Common Guava Blue (*Virachola isocrates*)
41	Oxalidaceae	*Oxalis corniculata*	Pale Grass Blue (*Pseudozizeeria maha*)
42	Poaceae	*Bambusa sp.*	Common Redeye (*Matapa aria*), Duffer (*Discophora sondaica*)
43		*Oryza sativa*	Swift (*Borbo* sp.; *Pelopidas* sp.; *Parnara* sp.)
44		*Eleusine indica*	Common Evening Brown (*Melanitis leda*)
45	Portulacaceae	*Portulaca oleracea*	Oriental Great Eggfly (*Hypolimnas bolina*), Danaid Eggfly (Hypolimnas misippus)
46	Rhamnaceae	*Ziziphus mauritiana*	Common Pierrow(*Castalius rosimon*),Common Silverline(*Spindasis vulcanus*), Chestnut-streaked Sailer(*Neptis jumbah*)
47	Rubiaceae	*Neolamarckia cadamba*	Commander (*Moduza procris*)
48	Rutaceae	*Aegle marmelos*	Common Mormon (*Papilio polytes*), Lime Swallowtail (*Papilio demoleus*)
49		*Citrus maxima*	Blue Mormon(*Papilio polymnestor*), Common Mormon(*Papilio polytes*), Lime Blues (*Chilades lajus*)
50		*Citrus limon*	Common Mormon (*Papilio polytes*), Lime Swallowtail(*Papilio demoleus*), Blue Mormon(*Papilio polymnestor*), Lime Blues(*Chilades lajus*), Common Banded Peacock (*Papilio crino*)
51		*Murraya koenigii*	Common Mormon (*Papilio polytes*), Lime Swallowtail (*Papilio demoleus*)
52		*Glycosmis pentaphylla*	Common Mormon(*Papilio polytes*), Lime Swallowtail (*Papilio demoleus*), Common Quaker (*Neopithecops zalmora*), Blue Mormon (*Papilio polymnestor*)
53	Verbenaceae	*Phyla nodiflora*	Peacock Pansy (*Junonia almana*)
54	Zingiberaceae	*Curcuma longa*	Grass Demon (*Udaspes folus*)

It is well known that the floral characteristics affect nectar-feeding of adult butterflies (Tiple *et al*. 2005) [48]. When they consume nectar, a mutual relationship made with each variety of plants. Some butterfly species travel long distances and transport pollen between plants that are located far away. This pollination creates genetic variation within the plant species, improving their chances of surviving against various diseases (Ghazanfar *et al*. 2016) [12].

Thus, they play a crucial role by supporting butterfly diversity (Kitahara *et al*. 2008) [20]. From our study sites, we have recorded 77 nectar plants from 29 families (Table 3).

Table 3: List of plants with observed butterflies collecting nectar and pollen

Sl. No.	Family	Scientific Name of Nectarine Plants	Depending Butterfly (s)
1	Acanthaceae	*Ecbolium ligustrinum*	Blue Mormon (*Papilio polymnestor*), Common Mormon (*Papilio polytes*), Common Rose (*Pachliopta aristolochiae*)
2		*Ruellia tuberosa*	Tiny Grass Blue (*Zizula hylax*), Pale Grass Blue (*Pseudozizeeria maha*),Lesser Grass Blue (*Zizina otis*), Grey Pansy (*Junonia atlites*),Common Grass Yellow (Eurema hecabe), Swift sp.
3		*Justicia adhatoda*	Common Mormon (*Papilio polytes*), Lemon Emigrant (*Catopsilia pomona*), Swift sp.
4		*Hygrophila difformis*	Gram Blue (*Euchrysops cnejus*), Pale Grass Blue (*Pseudozizeeria maha*),Lesser Grass Blue (*Zizina otis*), Tiny Grass Blue (*Zizula hylax*), Swift sp.
5	Amaranthaceae	*Alternanthera philoxeroides*	Gram Blue (*Euchrysops cnejus*), Pale Grass Blue (*Pseudozizeeria maha*), Dark Grass Blue (*Zizeeria karsandra*),Tiny Grass Blue (*Zizula hylax*), Swift sp.
6		*Alternanthera ficoidea*	Gram Blue (*Euchrysops cnejus*), Pale Grass Blue (*Pseudozizeeria maha*),Lesser Grass Blue (*Zizina otis*), Tiny Grass Blue (*Zizula hylax*), Swift sp.
7	Apocynaceae	*Tabernaemontana coronaria*	Grass Demon (*Udaspes folus*), Grey Pansy (*Junonia atlites*), Indian Wanderer (*Pareronia hippia*), Common Mormon (*Papilio polytes*), Slate Flash (*Rapala manea*), Swift sp.
8		*Calotropis gigantea*	Plain Tiger (*Danaus chrysippus*), Common Silverline (*Spindasis vulcanus*)
9		*Allamanda cathartica*	Lemon Emigrant (*Catopsilia pomona*), Common Mormon (*Papilio polytes*)
10		*Catharanthus roseus*	Grey Pansy (*Junonia atlites*), Lemon Emigrant (*Catopsilia pomona*)
11		*Carissa* sp.	Yellow Orage Tip (*Ixias pyrene*)
12	Asteraceae	*Blumea laciniata*	Psyche (*Leptosia nina*), Common Grass Yellow (*Eurema hecabe*)
13		*Eclipta prostrata*	Psyche (*Leptosia nina*), Common Grass Yellow (*Eurema hecabe*),Small Salmon Arab (*Colotis amata*), Common Gull (*Cepora nerissa*), Swift sp.
14		*Tagetes sp.*	Broad-tail Royal (*Creon cleobis*),Grey Pansy (*Junonia atlites*),Common Grass Yellow (*Eurema hecabe*), Lemon Emigrant (*Catopsilia pomona*), Common Mormon (*Papilio polytes*), Lime Swallowtail (*Papilio demoleus*), Common Crow (*Euploea core*), King Crow (*Euploea klugii*), Blue Tiger (*Tirumala limniace*), Indian Wanderer (*Pareronia hippia*),Swift sp.
15		*Cyanthillium cinereum*	Common Cerulean (*Jamides celeno*),Pale Grass Blue (*Pseudozizeeria maha*), Small Salmon Arab (*Colotis amata*), Psyche (*Leptosia nina*)
16		*Sphagneticola trilobata*	Grey Pansy (*Junonia atlites*), Lemon Pansy (*Junonia lemonias*), Peacock Pansy (*Junonia almana*), Blue Tiger (*Tirumala limniace*), Common Grass Yellow (*Eurema hecabe*), Pale Grass Blue (*Pseudozizeeria maha*), Swift sp.
17		*Parthenium sp.*	Common Grass Yellow (*Eurema hecabe*), Lime Swallowtail (*Papilio demoleus*), Common Gull (*Cepora nerissa*)
18		*Pluchea indica*	Common Gull (*Cepora nerissa*), Common Grass Yellow (*Eurema hecabe*), Grey Pansy (*Junonia atlites*), Lemon Emigrant (*Catopsilia pomona*), Swift sp.
19		*Tridax procumbens*	Plain Tiger (*Danaus chrysippus*), Gram Blue (*Euchrysops cnejus*), Pale Grass Blue (*Pseudozizeeria maha*), Plains Cupid (*Chilades pandava*), Tawny Coster (*Acraea terpsicore*), Common Grass Yellow (*Eurema hecabe*)
20		*Cosmos sp.*	Lemon Pansy (*Junonia lemonias*), Peacock Pansy (*Junonia almana*)
21		*Mikania micrantha*	Common Gull (*Cepora nerissa*), Grey Pansy (*Junonia atlites*), Peacock Pansy (*Junonia almana*),Blue Tiger (*Tirumala limniace*), Plain Tiger (*Danaus chrysippus*)
22	Balsaminaceae	*Impatiens balsamina*	Common Grass Yellow (*Eurema hecabe*), Lemon Emigrant (*Catopsilia pomona*), Common Mormon (*Papilio polytes*), Lime Swallowtail (*Papilio demoleus*), Indian Wanderer (*Pareronia hippia*), Swift sp.
23	Boraginaceae	*Heliotropium indicum*	Common Crow (*Euploea core*), King Crow (*Euploea klugii*), Blue Tiger (*Tirumala limniace*), Psyche (*Leptosia nina*)
24	Brassicaceae	*Brassica Juncea*	Common Gull (*Cepora nerissa*), Grey Pansy (*Junonia atlites*), Peacock Pansy (*Junonia almana*), Common Mormon (*Papilio polytes*)
25	Cleomaceae	*Cleome viscosa*	Common Gull (*Cepora nerissa*), Small Salmon Arab (*Colotis amata*), Common Grass Yellow (*Eurema hecabe*), Eastern-striped Albatross (*Appias olferna*), Psyche (*Leptosia nina*), Lesser Grass

			Blue (*Zizina otis*)
26	Combretaceae	*Terminalia chebula*	Striped Tiger (*Danaus genutia*), Lemon Pansy (*Junonia lemonias*)
27	Commelinaceae	*Commelina benghalensis*	Pale Grass Blue (*Pseudozizeeria maha*), Lesser Grass Blue (*Zizina otis*), Dark Grass Blue (*Zizeeria karsandra*),Tiny Grass Blue (*Zizula hylax*), Peacock Pansy (*Junonia almana*)
28	Convolvulaceae	*Ipomoea sp.*	Oriental Great Eggfly (*Hypolimnas bolina*), Lemon Emigrant (*Catopsilia pomona*), Pale Grass Blue (*Pseudozizeeria maha*)
29	Cucurbitaceae	*Cucumis sativus*	Swift sp., Peacock Pansy (*Junonia almana*)
30		*Momordica charantia*	Common Mormon (*Papilio polytes*),Swift sp., Common Grass Yellow (*Eurema hecabe*)
31		*Cucurbita maxima*	Common Mormon (*Papilio polytes*), Swift sp.,Common Branded Redeye (*Matapa aria*)
32		*Coccinia grandis*	Lime Swallowtail (*Papilio demoleus*), Common Mormon (*Papilio polytes*), Common Grass Yellow (*Eurema hecabe*)
33		*Luffa cylindrica*	Lime Swallowtail (*Papilio demoleus*), Common Mormon (*Papilio polytes*), Common Grass Yellow (*Eurema hecabe*)
34		*Cucumis sativus*	Common Grass Yellow (*Eurema hecabe*), Pale Grass Blue (*Pseudozizeeria maha*), Lesser Grass Blue (*Zizina otis*), Swift sp.
35		*Luffa acutangula*	Common Grass Yellow (*Eurema hecabe*), Common Branded Redeye (*Matapa aria*), Swift sp.
36	Euphorbiaceae	*Jatropha gossypifolia*	Common Gull (*Cepora nerissa*), Lemon Emigrant (*Catopsilia pomona*), Yellow Orange Tip (*Ixias pyrene*) Mottled Emigrant (*Catopsilia pyranthe*), Eastern Striped Albatross(*Appias olferna*)
37	Fabaceae	*Senna sophera*	Lemon Emigrant (*Catopsilia pomona*), Mottled Emigrant (*Catopsilia pyranthe*),
38		*Senna alata*	Lemon Emigrant (*Catopsilia pomona*), Mottled Emigrant (*Catopsilia pyranthe*),Common Grass Yellow (*Eurema hecabe*)
39		*Senna siamea*	Lemon Emigrant (*Catopsilia pomona*), Mottled Emigrant (*Catopsilia pyranthe*)
40		*Senna occidentalis*	Lemon Emigrant (*Catopsilia pomona*), Mottled Emigrant (*Catopsilia pyranthe*)
41		*Sesbania aculeata*	Common Grass Yellow (*Eurema hecabe*)
42		*Cassia fistula*	Lemon Emigrant (*Catopsilia pomona)*, Mottled Emigrant(*Catopsilia pyranthe*), Common Grass Yellow (*Eurema hecabe*)
43		*Samanea saman*	Indian Jezebel (*Delias eucharis*)
44		*Albizia lebbeck*	Common Rose (*Pachliopta aristolochiae*), Indian Jezebel (*Delias eucharis*), Lemon Emigrant(*Catopsilia pomona*), Lime Swallowtail (*Papilio demoleus*), Crow (*Euploea sp*.), Blue Tiger (*Tirumala limniace*)
45		*Delonix regia*	Lemon Emigrant (*Catopsilia pomona*), Mottled Emigrant (*Catopsilia pyranthe*)
46		*Saraca asoca*	Common Mormon (*Papilio polytes*), Blue Mormon (*Papilio polymnestor*), Lime Swallowtail (*Papilio demoleus*), Emigrant (*Catopsilia* sp.)
47		*Canavalia gladiata*	Gram Blue (*Euchrysops cnejus*)
48		*Vigna radiata*	Gram Blue (*Euchrysops cnejus*), Pea Blue (*Lampides boeticus*), Common Grass Yellow (*Eurema hecabe*)
49		*Clitoria ternatea*	Grey Pansy (*Junonia atlites*), Common Mormon (*Papilio polytes*), Lemon Pansy (*Junonia lemonias*)
50		*Millettia pinnata*	Common Cerulean (*Jamides celeno*),Dark Cerulean (*Jamides bochus*), Indian Sunbeam (*Curetis thetis*), Common Banded Awl (*Hasora chromus*)
51		*Bauhinia acuminata*	Lemon Emigrant (*Catopsilia pomona*), Common Mormon (*Papilio polytes*)
52	Lamiaceae	*Clerodendrum infortunatum*	Plain Tiger (*Danaus chrysippus*), Striped Tiger (*Danaus genutia*), Common Crow (*Euploea core*)
53		*Vitex negundo*	Common Gull (*Cepora nerissa*), Lemon Emigrant (*Catopsilia pomona*), Eastern Striped Albatross (*Appias olferna*)
54		*Anisomeles indica*	Lime Swallowtail (*Papilio demoleus*), Common Crow (*Euploea core*), Blue Tiger (*Tirumala limniace*), Grey Pansy (*Junonia atlites*), Swift sp.
55	Leguminosae.	*Arachis hypogaea*	Pale Grass Blue (*Pseudozizeeria maha*), Lesser Grass Blue (*Zizina otis*), Swift sp., Common Grass Yellow (*Eurema hecabe*), Gram Blue (*Euchrysops cnejus*), Pea Blue (*Lampides boeticus*)
56	Malvaceae	*Hibiscus rosa-sinenesis*	Common Mormon (*Papilio polytes*), Blue Mormon (*Papilio polymnestor*), Lime Swallowtail (*Papilio demoleus*), Emigrant (*Catopsilia* sp.), Indian Wanderer (*Pareronia hippia*)
57		*Abutilon indicum*	Common Gull (*Cepora nerissa*),Common Grass Yellow (*Eurema hecabe*)

58	Moraceae	*Streblus asper*	Grey Pansy (*Junonia atlites*), Commander (*Moduza procris*)
59	Moringaceae	*Moringa oleifera*	Indian Jezebel (*Delias eucharis*), Common Grass Yellow (*Eurema hecabe*),
60	Myrtaceae	*Syzygium cumini*	Grey Pansy (*Junonia atlites*), Lemon Pansy (*Junonia lemonias*), Peacock Pansy (*Junonia almana*), Slate Flash (*Rapala manea*), Common Guava Blue (*Virachola isocrates*), Grey Pansy (*Junonia atlites*), Grey Pansy (*Junonia atlites*),
61		*Syzygium samarangense*	Common Mormon (*Papilio polytes*), Grey Pansy (*Junonia atlites*), Lemon Pansy (*Junonia lemonias*), Peacock Pansy (*Junonia almana*), Slate Flash (*Rapala manea*),
62	Nyctaginaceae	*Bougainvillea spectabilis*	Common Mormon (*Papilio polytes*), Lemon Emigrant (*Catopsilia pomona*)
63		*Mirabilis jalapa*	Common Mormon (*Papilio polytes*)
64	Passifloraceae	*Turnera ulmifolia*	Lime Blues (*Chilades lajus*),Gram Blue (*Euchrysops cnejus*), Pea Blue (*Lampides boeticus*), Plains Cupid (*Chilades pandava*), Common Mormon (*Papilio polytes)*, Indian Wanderer (*Pareronia hippia*),
65	Poaceae	*Oryza sativa*	Swift sp., Peacock Pansy (*Junonia almana*)
66	Rubiaceae	*Mitragyna parvifolia*	Lemon Emigrant (*Catopsilia pomona*), Common Crow (*Euploea core*), Blue Tiger (*Tirumala limniace*), Indian Jezebel (*Delias eucharis*), Tailed Jay (*Graphium agamemnon*), Common Rose (*Pachliopta aristolochiae*)
67		*Neolamarckia cadamba*	Common Baron (*Euthalia aconthea*), Commander(*Moduza procris*), Black Rajah (*Charaxes solon*),Tailed Jay (*Graphium agamemnon*)
68		*Ixora coccinea*	Common Mormon (*Papilio polytes*), Lemon Emigrant (*Catopsilia pomona*),Yellow Orange-tip (*Ixias pyrene*), Lime Swallowtail (*Papilio demoleus*), Grey Pansy (Junonia atlites), Common Mime (*Papilio clytia*), Swift sp.
69		*Gardenia jasminoides*	Common Mormon (*Papilio polytes*), Blue Mormon (*Papilio polymnestor*), Lime Swallowtail (*Papilio demoleus*)
70	Rutaceae	*Murraya paniculata*	Indian Wanderer (Pareronia hippia), Common Mormon (*Papilio polytes*)
71		*Glycosmis pentaphylla*	Common Mormon (*Papilio polytes*), Common Quaker (*Neopithecops zalmora*)
72	Sapotaceae	*Miusops elengi*	Line Blue (*Prosotas* sp.), Common Baron (*Euthalia aconthea*)
73		*Manilkara zapota*	Common Baron (*Euthalia aconthea*)
74	Solanaceae	*Solanum nigrum*	Common Gull (*Cepora nerissa*)
75	Verbenaceae	*Lippia alba*	Tailed Jay (*Graphium agamemnon*), Lime Swallowtail (*Papilio demoleus*), Common Mime (*Papilio clytia*), Common Gull (*Cepora nerissa*), Eastern Striped Albatross(*Appias olferna*), Psyche (*Leptosia nina*),Lemon Emigrant (*Catopsilia pomona)*, Mottled Emigrant (*Catopsilia pyranthe*), Common Grass Yellow (*Eurema hecabe*), Small Salmon Arab (*Colotis amata*), Common Leopard (*Phalanta phalantha*), Grey Pansy (*Junonia atlites*), Lemon Pansy (*Junonia lemonias*), Peacock Pansy (*Junonia almana*), Blue Tiger (*Tirumala limniace*), Common Silverline (*Spindasis vulcanus*), Swift sp., Painted Lady (*Vanessa cardui*),Plain Tiger (*Danaus chrysippus*)
76		*Phyla nodiflora*	Grey Pansy (*Junonia atlites*), Lemon Pansy (*Junonia lemonias*), Peacock Pansy (*Junonia almana*), Tiny Grass Blue (*Zizula hylax*)
77	Vitaceae	*Cayratia trifolia*	Peacock Pansy (*Junonia almana*), Common Gull (*Cepora nerissa*), Common Mime (*Papilio clytia*), Swift sp., Eastern Striped Albatross (*Appias olferna*), Grey Pansy (*Junonia atlites*), Common Grass Yellow (*Eurema hecabe*)

But over the last few decades, excessive use of pesticides, particularly insecticides have also been found harmful to the non-target species (Braak *et al*. 2018) [4]. Thus, application of herbicides always risking the butterfly populations (Russell & Schultz 2010) [40]. When Lepidopterans directly killed by the insecticides and herbicides, it results in sublethal changes in fecundity and longevity which in turn, affects the diversity of its nectar and larval host plants (Longley & Sotherton 1997) [26]. Moreover, direct exposure of pesticide residue to the caterpillars results in death or hampered development (Olaya-Arenas *et al*. 2020) [33]. The harmful pesticides and herbicides which are used in agricultural fields or other parts of rural areas are given below (Table 4).

Table 4: Chemical composition of pesticides and herbicides and their mode of action.

Chemical composition of Pesticides	Mode of action
Chlorantraniliprole 18.5% SC	Used to control a range of pests belonging to the order Lepidoptera and some other Coleoptera, Diptera and Isoptera species (Hannig *et al*. 2009) [14].
Chloropyrfos-50% EC, Cypernethrin-5% EC	Chlorpyrifos is a broad-spectrum organophosphate insecticide that has been used in agriculture for more than a decade (Rusyniak & Nañagas 2004) [41]. It is accumulated in a variety of aquatic organisms (Deb & Das 2013) [7]. Cypermethrin a class II pyrethroid pesticide. It is used to control insects in the household and agricultural fields. It has neurotoxic effects on different species (Sharma *et al*. 2014) [43].
Deltamethrin 1%, Triazophos 35% EC	Deltamethrin is effective against insects via ingestion and direct contact (Tomlin, 2006) [50]. It may also affect ion channels in the nervous system (Burr & Ray 2004) [5]. Triazophos is a broad-spectrum insecticide and used to control lepidopteran insects in rice fields. (Ge *et al*. 2011) [11]
Acephate 75%	It is a systemic insecticide used to control sucking and biting insects by direct contact or ingestion (Bharpoda *et al*. 2014) [2].
Methyl Parathion 2% DP	Methyl parathion (MP), an organophosphorus insecticide with high activity against a variety of insect pests, is used in agriculture and aquaculture all over the world (Monteiro *et al*. 2006) [30].
Organophosphorus 48% EC	It effects on both insects' and mammals' nervous system by inhibiting acetylcholinesterase (AChE). The function of acetylcholinesterase is to break down the neurotransmitter acetylcholine which is released at cholinergic nerve endings in response to nervous stimuli (Elersek & Filipic 2011) [10].
Biofenthrin10% EC	It is a synthetic pyrethroid used to control a wide range of insect pests in a variety of applications. It has a broad spectrum of insecticidal and acaricidal activity (Monteiro *et al*. 2006) [30].
Cypermethrin10% EC	Cypermethrin a class II pyrethroid pesticide. This insecticide is frequently used in agricultural practises to control a variety of insect pests, especially those from the orders Lepidoptera and Coleoptera (Baruah & Chaurasia 2020) [1].
Chlorantraniliprole 0.4% GR	An innovative anthranilic diamide insecticide called chlorantraniliprole is effective against some species of Coleoptera, Diptera, and Hemiptera as well as lepidopteran insect pests. Additionally, it works well against insect populations that have become resistant to other types of insecticides. (Hannig *et al*. 2009) [14]
Chemical composition of Herbicides	**Mode of action**
Paraquat dichloride 24% SL	It is a non-selective contact herbicide that works well to control grasses and weeds with broad leaves. During photosynthesis superoxide generated, which damages cell membranes and cytoplasm.
Pyrazosulfuron Ethyl 10% WP	These herbicides gradually decreased dominant broadleaved, grass and sedge weeds in the paddy field (Ramesha *et al*. 2017) [36].
Ammonium salt of glyphosate 71% SG	It is effective to control the weeds especially annual broadleaf weeds and grasses that compete with crops.
Butachlor 50% EC	It is used as a selective pre-emergent herbicide that inhibits growth and reduces cell division. It offers reliable pre-emergence to early post-emergence control of annual grasses, some sedges and broadleaf weeds for high yield in transplanted and dry-sown rice cropping systems.
Sodium Acifluorfen 16.5% + Clodinafop-Propargyl 8% EC.	It is a systemic herbicides and used to killed weeds *Echinochloa sp., Eleusine indica*, in crop land.
Isopropyl-amine salt of glyphosate	It is a broad-spectrum systemic herbicide and an organophosphorus compound. It is used to kill weeds, mainly annual broadleaf weeds and grasses that compete with crops.
Penoxsulam 0.9%, Butachlor 38.8% SE	It is used to control broadleaf, sedge, and grass weeds in transplanted, dry-seeded, and water-seeded rice. This herbicide is also effective against broadleaf weeds.
Oxadiargyl	It is very effective for the control of grasses, sedges and some broad leaf weeds in rice.
Quizalofop Ethyl 5% EC	Systemic herbicide, absorbed from the leaf surface, with translocation throughout the plant, moving in both the xylem and phloem, and accumulating in the meristematic tissue of annual and perennial grass weeds.

Discussion

From our study, we have recorded a total number of 80 species, in which Lycaenidae family has the highest number of species because of rich diversity of low-growing herbs in agricultural fields and roadside vegetation.

There are so many studies done on butterfly diversity from different parts of Purba Medinipur districts. From the Digha coastal area, Jana *et al*. (2013) [16] recorded 27 species of butterflies where Pieridae family has the greatest number of species. Hajra *et al*. (2015) [13] documented 46 species of butterflies from the Contai region of this district where Nymphalidae family was dominating over other families. Later, Payra *et al*. (2017) [35] made a checklist from the coastal zone where they had recorded 112 butterfly species and both Nymphalidae and Lycaenidae family were dominant over others in respect of species count. Pahari *et al*. (2018) [34] also recorded 67 species of butterflies from Haldia industrial belt and adjacent rural areas. They showed that the diversity of Lycaenidae family was higher in rural areas than the industrial area. Studies on butterfly diversity by Dwari & Mondal (2020) [9] in Jhargram, Paschim and Purba Medinipur Districts shows that 117 species of butterflies were found from Purba Medinipur district alone. Mahata *et al*. (2020) [28] also studied on butterflies from undivided Medinipur and they have recorded 98 species of butterflies where Nymphalidae family claimed highest species. Among these 80 species, we found that 14 were very rare, which means they have been seen only once or twice in a year. These species were *Papilio crino, Mycalesis perseus, Junonia iphita, Junonia orithya, Vanessa cardui, Hypolimnas misippus, Iraota timoleon, Spalgis epius, Virachola Isocrates, Anthene emolus, Creon cleobis, Spindasis vulcanus , Badamia exclamationis* and *Tagiades japetus.* According to the Indian Wildlife (Protection) Act of 1972, three species are under Schedule I category namely *Pachliopta hector, Danaus genutia* and *Discophora sondaica*. Seven species are under Schedule II category namely *Charaxes solon, Hypolimnas misippus, Euchrysops cnejus, Lampides boeticus, Virachola Isocrates, Anthene lycaenina* and *Tagiades japetus*. Only one species is under Schedule IV category which is *Euploea klugii*. So, the rich diversity of host plants and nectar plants confirm that this area needs attention to taken care of this butterfly habitat. Attractive nectar plants, like *Lippia alba, Sphagneticola*

trilobata, Jatropha gossypifolia, Syzygium cumini, Mitragyna parvifolia, Neolamarckia cadamba, Cayratia trifolia etc. were also documented during the study. But most agricultural fields are facing common problems these days - cattle grazing and man-made fire (Rodgers, 1986; Kunte, 1997) [39] along with the major problem, unrestricted and excessive use of pesticide and herbicides causing the destruction of whole diversity. These help to protect the crops from pests but also have a detrimental effect on the environment. These chemicals not only used in agricultural fields but also used control weeds and pests around our residence, pools, roads and other places (Mahmood *et al.* 2015) [29]. While spraying, some volatile part of these chemicals also mix into the air and affect various non-target species (Straathoff, 1986) [45]. Accumulation of pesticides in the food chain directly affects the population of predators and raptors along with other rare species (Mahmood *et al.*2015) [29].

Conclusion

The present study proves a good variety and abundance of butterfly present in Egra block. Good diversity of host plants and nectar plants in these areas reflects this rich butterfly diversity. The plants which are considered as weeds, also play a crucial role in butterfly conservation. Still, as the survey was done in a short time span, a long-term study would show a better result. Habitat alternation by deforestation also has huge impact on decrease of the butterfly diversity. Awareness on the importance of pollinators in agriculture would give some hope. Reduced use of the chemical pesticides, herbicides and fertilizers and shifting towards organic pesticides and herbicides will decrease the harmful effects on the beneficial pollinators.

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References

1. Baruah P, Chaurasia N. Ecotoxicological effects of alpha-cypermethrin on freshwater alga Chlorella sp.: Growth inhibition and oxidative stress studies. Environmental Toxicology and Pharmacology,2020:76:103347.
2. Bharpoda TM, Patel NB, Thumar RK, Bhatt NA, Ghetiya LV, Patel HC, Borad PK. Evaluation of insecticides against sucking insect pests infesting Bt cotton BG-II. The bioscan,2014:9(3):977-80.
3. Biswas SJ, Patra D, Roy S, Giri SK, Pal S, Hossain A. Butterfly diversity throughout Midnapore urban area in West Bengal, India. Journal of Threatened Taxa, 2019:11(14):14816-26.
4. Braak N, Neve R, Jones AK, Gibbs M, Breuker CJ. The effects of insecticides on butterflies–A review. Environmental pollution,2018:242:507-18.
5. Burr SA, Ray DE. Structure-activity and interaction effects of 14 different pyrethroids on voltage-gated chloride ion channels. Toxicol. Sci,2004:77:341-346.
6. Clark PJ, Reed JM, Chew FS. Effects of urbanization on butterfly species richness, guild structure, and rarity. Urban Ecosystems,2007:10(3):321-37.
7. Deb N, Das S. Chlorpyrifos toxicity in fish: a review. Current World Environment,2013:8(1):77.
8. Dennis RL, Hodgson JG, Grenyer R, Shreeve TG, Roy DB. Host plants and butterfly biology. Do host-plant strategies drive butterfly status?. Ecological Entomology,2004:29(1):12-26.
9. Dwari S, Mondal AK. Diversity of Butterflies (Lepidoptera: Rhopalocera) of Jhargram, Purba and Paschim Medinipur Districts, West Bengal, India. Global Journal of Science Frontier Research: C Biological Science,2020:20(4):35-61.
10. Eleršek T, Filipič M. Organophosphorus pesticides-mechanisms of their toxicity. Pesticides-the impacts of pesticide exposure, 2011, 243-60.
11. Ge LQ, Zhao KF, Huang LJ, Wu JC. The effects of triazophos on the trehalose content, trehalase activity and their gene expression in the brown planthopper Nilaparvata lugens (Stål)(Hemiptera: Delphacidae). Pesticide Biochemistry and Physiology,2011:100(2):172-81.
12. Ghazanfar M, Malik MF, Hussain M, Iqbal R, Younas M. Butterflies and their contribution in ecosystem: A review. Journal of Entomology and Zoology Studies,2016:4(2):115-8.
13. Hajra K, Mandal P, Jana S, Jana S, Sahoo A. Diversity of Butterfly in Contai and its adjoining areas Purba Medinipur, West Bengal, India. International Journal of Current Research and Academic Review,2015:3(6):246-58.
14. Hannig GT, Ziegler M, Marcon PG. Feeding cessation effects of chlorantraniliprole, a new anthranilic diamide insecticide, in comparison with several insecticides in distinct chemical classes and mode-of-action groups. Pest Management Science: formerly Pesticide Science,2009:65(9):969-974.
15. Hossain A, Aditya G. Avian diversity in agricultural landscape: records from Burdwan, West Bengal, India. InProceedings of the Zoological Society. Springer India, 2016, 69(1):38-51.
16. Jana D, Giri S, Tamili DK, Chakraborty SK. Diversity of lepidopteran insects in the coastal regions of Midnapur (East), West Bengal, India. Indian Journal of Biological Sciences,2013:19:32-41.
17. Karan C, Bhushan S, Mondal M. Dynamic Concept of Coastal Agricultural Landuse and Agricultural Resources-A Case study at Egra Block-I and Egra Block-II, Purba Medinipur, WB, India. International Research Journal of Social Sciences, 2015.
18. Kasambe R. Butterflies of Western Ghats. An e-Book, 2018, 372.
19. Kehimkar ID. Book of Indian butterflies. Bombay Natural History Society and Oxford University Press, 2008, 497.
20. Kitahara M, Yumoto M, Kobayashi T. Relationship of butterfly diversity with nectar plant species richness in and around the Aokigahara primary woodland of Mount Fuji, central Japan. Biodiversity and conservation,2008:17(11):2713-34.

21. Knops JM, Tilman D, Haddad NM, Naeem S, Mitchell CE, Haarstad J, Ritchie ME, Howe KM, Reich PB, Siemann E, Groth J. Effects of plant species richness on invasion dynamics, disease outbreaks, insect abundances and diversity. Ecology Letters,1999:2(5):286-93.
22. Kunte K, Sondhi S, & Roy P (Chief Editors). Butterflies of India, v. 3.03. Indian Foundation for Butterflies. URL: https://www.ifoundbutterflies.org.
23. Kunte K. Butterflies of Peninsular India Universities Press (India) Limited. Indian Academy of Sciences (Bangalore), 2000, 254.
24. Kunte KJ. Seasonal patterns in butterfly abundance and species diversity in four tropical habitats in northern Western Ghats. Journal of biosciences,1997:22(5):593-603.
25. Legally protected Indian butterflies. Wildlife (Protection) Act, 1972. https://www.ifoundbutterflies.org/WPA-protected-species.
26. Longley M, Sotherton NW. Factors determining the effects of pesticides upon butterflies inhabiting arable farmland. Agriculture, ecosystems & environment,1997:61(1):1-2.
27. Magurran AE. Measuring biological diversity. Current Biology,2021:11:31(19):R1174-7.
28. Mahata A, Mishra NP, Palita SK. Butterflies (Lepidoptera: Rhopalocera) of the undivided Midnapore District, West Bengal, India: a preliminary report. Journal of Threatened Taxa,2020:12(17):17347-60.
29. Mahmood I, Imadi SR, Shazadi K, Gul A, Hakeem KR. Effects of pesticides on environment. InPlant, soil and microbes, 2016, 253-269. Springer, Cham.. doi.;10:978-3.
30. Monteiro DA, De Almeida JA, Rantin FT, Kalinin AL. Oxidative stress biomarkers in the freshwater characid fish, Brycon cephalus, exposed to organophosphorus insecticide Folisuper 600 (methyl parathion). Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology,2006:143(2):141-9.
31. Muratet A, Fontaine B. Contrasting impacts of pesticides on butterflies and bumblebees in private gardens in France. Biological Conservation,2015:182:148-54.
32. Nimbalkar RK, Chandekar SK, Khunte SP. Butterfly diversity in relation to nectar food plants from Bhor Tahsil, Pune District, Maharashtra, India. Journal of Threatened Taxa,2011:3(3):1601-9.
33. Olaya-Arenas P, Hauri K, Scharf ME, Kaplan I. Larval pesticide exposure impacts monarch butterfly performance. Scientific reports,2020:10(1):1-12.
34. Pahari PR, Mishra NP, Sahoo A, Bhattacharya T. A study on the butterfly diversity of Haldia industrial belt and adjacent rural area in Purba Medinipur district, West Bengal, India. World Scientific News,2018:97:207-24.
35. Payra A, Mishra RK, Mondal K. Butterflies (Lepidoptera-Rhopalocera) of coastal areas of southern West Bengal, India. Tap chi Sinh hoc,2017:10:39(3):276-90.
36. Ramesha YM, Kumar MA, Bhanuvally M, Gaddi AK. Bio-efficacy of pyrazosulfuron ethyl 10% WP against weeds in transplanted rice. Journal of Applied and Natural Science,2017:9(3):1844-7.
37. Ray DE, Fry JR. A reassessment of the neurotoxicity of pyrethroid insecticides. Pharmacol. Ther,2006:111(1):174-193.
38. Robbins RK, Opler PA. Butterfly diversity and a preliminary comparison with bird and mammal diversity. Biodiversity II: understanding and protecting our biological resources,1997:69-82.
39. Rodgers WA. role of fire in the management of wildlife habitats: a review. Indian Forester, 1986.
40. Russell C, Schultz CB. Effects of grass-specific herbicides on butterflies: an experimental investigation to advance conservation efforts. Journal of Insect Conservation,2010:14(1):53-63.
41. Rusyniak DE, Nañagas KA. (2004, June). Organophosphate poisoning. In *Seminars in neurology*. Copyright© 2004 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA, 2004:24(2):197-204.
42. Shannon CE, Weaver W. The mathematical theory of communication. University of Illinois. Urbana, 1949, 117.
43. Sharma P, Firdous, S, Singh, R. Neurotoxic effect of cypermethrin and protective role of resveratrol in Wistar rats. International Journal of Nutrition, Pharmacology, Neurological Diseases,2014:4(2):104.
44. Simpson GG. Species density of North American recent mammals. Systematic zoology,1964:13(2):57-73.
45. STRAATHOF HM. Investigations on the phytotoxic relevance of volatilization of herbicides. Mededelingen van de Faculteit Landbouwwetenschappen. Rijksuniversiteit Gent,1986:51(2a):433-8.
46. Tam KC, Bonebrake TC. Butterfly diversity, habitat and vegetation usage in Hong Kong urban parks. Urban ecosystems,2016:19(2):721-33.
47. Thomas CD. Ecology and conservation of butterfly metapopulations in the fragmented British landscape. In Ecology and conservation of butterflies. Springer, Dordrecht, 1995, 46-63.
48. Tiple AD, Deshmukh VP, Dennis RL. Factors influencing nectar plant resource visits by butterflies on a university campus: implications for conservation. Nota lepidopterologica. 2005;28(3/4):213.
49. Tiple AD, Khurad AM, Dennis RL. Butterfly diversity in relation to a human-impact gradient on an Indian university campus. Nota lepidopterological,2007:30(1):179.
50. Tomlin, C. D. S. The Pesticide Manual: A World Compendium, 14th ed.; British Crop Protection Council: Farnham, UK, 2006, 286-287.