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Diversity of Butterflies in a Re-vegetated Habitat in Chennai, South India

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Abstract: Re-vegetating degraded habitats has shown considerable promise in restoring biodiversity locally and at the level of landscapes. Re-vegetation also known as 'greening' is being seen as a viable solution to climate change mitigation. Chennai is a mega-city in South India. A decade ago, major project aimed at re-vegetating a degraded coastal habitat was successfully completed by the government. The re-vegetated habitat is called Adyar Eco park or Tholkappiar Poonga. In this study we have discussed about the diversity of butterflies in the newly created urban habitat. The study was done over a period of 24 months starting January 2021 to December 2022. A total of 80 species representing five different families were observed during the study. The family Nymphalidae had the maximum number of species followed by Lycaenidae. Line transects were used to observe and pollard walk method was adopted for counting and recording data on butterflies. Large butterfly communities are attracted by the regions with undisturbed plants and a high floral range. Butterfly species along with their host and nectar plants were observed, identified and photo-documented. There were considerable monthly variations in the number of species of butterflies observed. Hence, the present study has revealed remarkable diversity of butterflies in a re-vegetated urban habitat.

Keywords: Butterflies, Diversity, Re-vegetation, Tholkappia Poonga, Nymphalidae, Lycaenidae

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Introduction

India is one of the mega-diverse countries in the world. It is also the most populous country. A bulk of the country's human population lives in cities causing tremendous pressures on the local ecology and biodiversity. Chennai is one of the oldest and largest city in India. It is a tropical coastal city. The Guindy National Park is the largest green area within the city. In addition to

this, there are green institutional campuses such as the Indian Institute of Technology Madras, Madras Christian College and Theosophical Society.

Between 2006 and 2011 the government launched an ambitious project to re-vegetate a highly degraded estuarine habitat popularly called the 'Adyar Creek'. The project aimed at creating

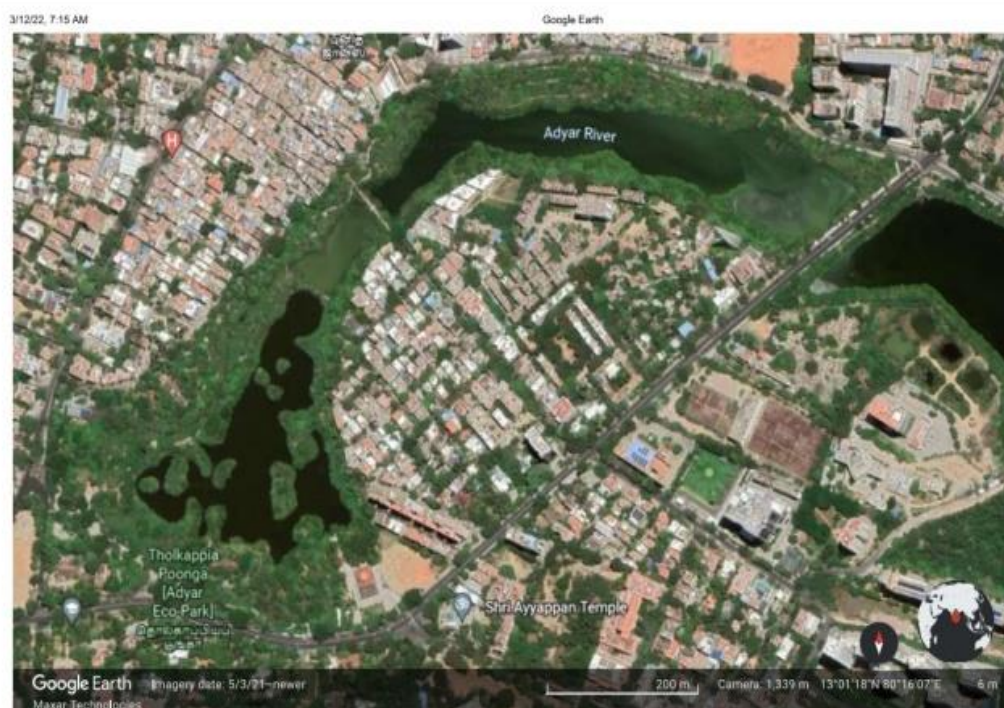


Fig. 1: Bird's Eye View of the Adyar Eco Park (Source: Google earth).

'green' patch locally in and around the estuary and establishing an 'eco park'. Ten years after completion of the project it has been observed that the eco park has provided habitat to several species of plants and animals thereby contributing to the overall biodiversity wealth of Chennai.

Butterflies are ideal creatures for assessing biodiversity in different terrestrial habitats. Adults are easily observed and most species can be identified in the field without much difficulty. These insects are very sensitive in that they quickly react to any kind of disturbance such as changes in the habitat quality, environmental influences, climatic change that affects temperature, humidity, rainfall, light levels, and availability of larval host plants and disturbances. (Erhardt, 1985; Byron and Gillman, 1998; Warren *et al.*, 2001; Eleanor *et al.*, 2015; Evangeline and Santhi, 2017, 2018). In this study we have discussed about the diversity of butterflies in the newly created urban habitat (Adyar Eco park or Tholkappiar Poonga). The study was done over a period of 24 months starting January 2021 to December 2022.

Materials and Methods

Study Area:

The study area Adyar Eco park (also known as *TholkappiarPoonga*) is located within the city of Chennai along the mouth of the Adyar River (12°93'N; 80°00'E) (Fig. 1). The maximum elevation within the study area is 5 m ASL (Above Sea Level). The climate is tropical and maritime. Annual rainfall is around 1200 mm. Much of the rainfall is received during the northeast monsoon (October-January). The study area (358 acres) was in a highly degraded condition till 2006 covered largely by the invasive alien species of tree *Prosopis juliflora*. Re-vegetation was done over a period of five years (2006-2011) using coastal tropical dry evergreen forests as a model. As a result, the re-vegetated habitat consists of several species of grasses, herbs, shrubs, and trees native to the region. The re-vegetated habitat is designed in such a way that it is easy to walk around and observe butterflies.

Methodology:

The present study was limited to 58 acres of the

re-vegetated habitat (Adyar Eco park or Tholkappiar Poonga). This is the area in which the first phase of the project was completed. The study was done over a period of 24 months starting January 2021 to December 2022. Line transects (Kunte, 1997, 2000; Evangeline and Santhi, 2017) were used to observe butterflies and the Pollard Walk (Pollard, 1979) method was adopted for counting and recording data on butterflies. All observations were limited to a width of 3 m on either side of the line transect. Sampling time varied from one to one and half hours between 8.30 h and 13.00 h (forenoon) and 15.00 h and 17.00 h in the evenings. Species that could not be identified in the field (example Lycaenidae and Hesperidae) were photographed using digital camera (Canon EOS 1500D) and later identified using standard literature (Evans, 1932; Wynter-Blyth, 1957; Kunte, 2000; Kehimkar 2008; Jahir *et al.*, 2008; Shobana *et al.*, 2012) and by using (Butterfly Vision) identification tool designed by Theivaprakasham Hari at the website (<https://butterflyvision.in>). The key characters such as colour pattern, wing span, mode of flight, etc. were also used for the identification purposes.

Results and Discussion

A total of 80 species of butterflies were observed during the study period. They represented five different families viz. Nymphalidae, Lycaenidae, Pieridae, Papilionidae and Hesperidae. Month-wise observation of the 80 different species of butterflies are presented in Table 1.

The family-wise distribution of species in the five different families of butterflies are given in Figure 2. 24.30% of the species was most dominant belonging to the family Nymphalidae and 21.26% represented the family Lycaenidae. Only 9.11% of the species belonged to the family Hesperidae.

The most common vegetation of this habitat includes herbs, lianas, shrubs, trees, and grass. This habitat includes trees and shrubs such as *Abrus precatorius*, *Acacia* spp., *Albizia* spp., *Azadirachta indica*, *Cadaba* spp., *Calotrophis* spp.,

Chloroxylon swietenia, *Citrus* spp., *Clausena* spp., *Crotalaria* spp., *Ricinus communis*, *Indigofera* spp., *Mangifera indica*, *Morinda tinctoria/citrifolia*, *Prosopis juliflora*, *Pongamia pinnata*, *Premna serratifolia/latifolia*, *Pithicellobium dulce*, *Psidium guajava*, *Pterospermum* spp., *Strychnos nuxvomica*, *Rhincanthus nastulus*, *Ficus* spp., *Abutilon* spp., *Dryptes* spp., *Maeura* spp., *Streblus asper*, *Murraya* spp., *Allophyllus cobbe*, *Cassia* spp., *Senna* spp., *Salvadora* spp., *Bougainvillea*, *Ixora* spp., *Polyalthia* spp., *Solanum* spp., etc. Some of the herbs, lianas, weeds, flowering plants, water plants and wetland grasses such as *Amaranthus* spp., *Asclepias* spp., *Calamus* spp., *Capparis* spp., *Cynodon* spp., *Derris* spp., *Grass* spp., *Lantana* spp., *Tridax procumbens*, *Leucas aspera*, *Water ipomea aquatica*, *Alternanthera* spp., *Asystasia gangetica*, *Clitoria ternatea*, *Passiflora* spp., *Turnera subulata*, *Ruellia* spp., *Sida* spp., *Tephrosia* spp., *Ziziphus oenopolia*, *Cyanthillium cinereum*, and *Walteria indica* are present in the habitat at the open areas of the landscape. Some of the larval and nectar plants of different butterfly species at Adyar Eco park region are illustrated in Table 2.

Frequency distribution of butterfly species was observed and identified during the duration of 2 years period is given in Figure 3.

Butterfly species varied considerably during different months. Most of the species were sighted throughout for 5, 9 and 12 months. Thirty species which are recorded in 5, 9 and 12 months amounts to (40%). These 30 species can be treated as the most common butterflies in the study area (Table 1). Ten species of butterflies such as *Danaus genutia*, *Junonia almanac*, *Elymnias hypermnestra*, *Appias albina*, *Delias eucharis*, *Jamides alecto*, *Castalius rosimon*, *Chilades trochylus*, *Udaspes folus* and *Hasora chromus* were sighted for five months. Eleven species of butterflies such as *Tirumala limniace*, *Junonia iphita*, *Eurema brigitta*, *Cepora nerissa*, *Hebomoia glaucippe*, *Colotis danae*, *Curetis thetis*, *Chilades parrhasius*, *Lampides boeticus*, *Pachliopta aristolochiae* and *Pelopidas mathias* were sighted

Table 1: Month-wise observation of the different species of butterflies

S. No.	Common name	Scientific name	Butterfly species observed during the year from January 2021-December 2022											
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Nymphalidae: (24)													
1	Plain Tiger	<i>Danaus chrysippus</i>	+	+	+	+	+	+	+	+	+	+	+	+
2	Striped Tiger	<i>Danaus genutia</i>	+	+	-	-	-	-	-	-	-	+	+	+
3	Blue Tiger	<i>Tirumala limniace</i>	+	+	+	+	+	-	+	+	-	-	+	+
4	Dark Blue Tiger	<i>Tirumala septentrionis</i>	-	-	+	+	-	-	-	+	-	-	+	-
5	Glassy Tiger	<i>Tirumala aglea</i>	-	-	-	-	-	-	-	+	-	-	+	-
6	Common Crow	<i>Euploea core</i>	+	+	+	+	+	+	+	+	+	+	+	+
7	Double Branded Crow	<i>Euploeasylvester</i>	+	+	-	-	+	+	-	-	+	+	+	+
8	Tawny Coster	<i>Acraea terpsicore</i>	+	+	+	+	+	+	+	+	+	+	+	+
9	Lemon Pansy	<i>Junonia lemonias</i>	-	+	-	+	-	+	+	+	+	+	-	-
10	Chocolate Pansy	<i>Junonia iphita</i>	+	-	-	+	-	+	+	+	+	+	+	+
11	Peacock Pansy	<i>Junonia almana</i>	-	+	-	+	-	-	-	-	+	+	+	-
12	Blue Pansy	<i>Junonia orithya</i>	-	-	+	-	-	-	-	+	-	-	-	-
13	Grey Pansy	<i>Junonia atlites</i>	-	-	-	+	-	-	+	-	-	-	+	-
14	Yellow Pansy	<i>Junonia hierta</i>	-	-	-	-	-	-	+	-	-	+	-	-
15	Great Eggfly	<i>Hypolimnas bolina</i>	-	-	+	+	-	-	-	-	+	+	+	+
16	Danaid Eggfly	<i>Hypolimas misippus</i>	-	+	-	-	+	+	+	-	+	+	-	+
17	Common Sailer	<i>Neptis hylas</i>	-	+	+	-	-	+	-	-	-	-	-	+
18	Common Castor	<i>Ariadne merione</i>	+	+	+	+	+	-	+	-	+	-	-	-
19	Angled Castor	<i>Ariadne ariadne</i>	+	+	+	+	-	-	-	-	+	+	-	-
20	Common Palmfly	<i>Elymnias hypermnestra</i>	-	-	+	-	-	-	-	+	+	+	+	-
21	Tailed Palmfly	<i>Elymnias caudata</i>	-	-	+	-	-	-	-	-	+	-	-	-
22	Common Baron	<i>Euthalia aconthea</i>	-	-	-	-	-	-	+	-	-	-	-	-
23	Common Leopard	<i>Phalanta phalantha</i>	+	-	-	-	-	-	-	+	+	-	-	+
24	Common Evening Brown	<i>Melanitis leda</i>	+	+	+	-	-	+	-	-	-	-	-	-
	Pieridae: (16)													
25	Common Grass Yellow	<i>Eurema hecabe</i>	+	+	+	+	+	+	+	+	+	+	+	+
26	Small Grass Yellow	<i>Eurema brigitta</i>	+	+	+	+	-	-	-	+	+	+	+	+
27	Small Salmon Arab	<i>Colotis amata</i>	+	+	+	+	+	+	+	+	+	+	+	+
28	Large Salmon Arab	<i>Colotis fausta</i>	-	-	-	-	-	+	-	-	+	+	-	-
29	Common/ Lemon Emigrant	<i>Catopsilia pomona</i>	+	+	+	+	+	+	+	+	+	+	+	+
30	Mottled Emigrant	<i>Catopsilia pyranthe</i>	+	+	+	+	-	+	+	-	+	+	+	+
31	Common Wanderer	<i>Pareronia hippia</i>	+	+	+	+	-	+	-	+	+	+	+	+
32	Common Albatross	<i>Appias albina</i>	-	-	-	+	+	+	+	-	+	-	-	-
33	Striped Albatross	<i>Appias libythea</i>	-	+	+	-	-	-	-	-	-	-	+	+
34	Common Gull	<i>Cepora nerissa</i>	+	+	+	+	+	-	+	+	-	+	-	+
35	Psyche	<i>Leptosia nina</i>	+	+	+	+	+	-	-	+	+	+	+	+
36	Great Orange Tip	<i>Hebomoia glaucippe</i>	+	+	+	+	-	-	-	+	+	+	+	+
37	Small Orange Tip	<i>Colotis etrida</i>	+	+	+	-	-	+	+	+	+	+	-	-

38	Yellow Orange Tip	<i>Ixias pyrene</i>	+	+	+	+	-	-	-	+	+	+	-	-
39	Crimson Tip	<i>Colotis danae</i>	-	+	+	+	-	+	+	+	+	+	-	+
40	Common Jezebel	<i>Delias eucharis</i>	+	+	+	-	-	-	-	-	+	+	-	-
	Lycaenidae: (21)													
41	Common Cerulean	<i>Jamides celeno</i>	+	+	+	+	+	+	+	+	+	+	+	+
42	Dark Cerulean	<i>Jamides sbochus</i>	-	+	+	+	+	+	+	+	+	+	-	+
43	Metallic Cerulean	<i>Jamides alecto</i>	-	-	+	+	-	-	-	-	+	+	-	+
44	African Babul Blue	<i>Azanus jesous</i>	-	+	-	-	-	-	-	-	+	+	-	-
45	Lime Blue	<i>Chilades lajus</i>	-	+	-	-	-	+	+	+	+	+	-	+
46	Zebra Blue	<i>Leptotes plinius</i>	-	-	-	+	-	+	+	-	+	-	-	-
47	Pale Grass Blue	<i>Pseudozizeeria maha</i>	-	+	+	+	-	+	-	+	+	-	+	+
48	Lesser Grass Blue	<i>Zizina otis</i>	-	+	+	+	-	+	+	+	+	+	+	+
49	Dark Grass Blue	<i>Zizeeria karsandra</i>	+	+	+	+	-	+	+	-	+	+	+	+
50	Tiny Grass Blue	<i>Zizula hylax</i>	+	+	-	+	-	+	+	+	+	+	+	+
51	Common Pierrot	<i>Castalius rosimon</i>	-	-	-	-	-	-	-	+	+	+	+	+
52	Indian Sunbeam	<i>Curetis thetis</i>	+	+	-	+	-	+	+	+	+	+	+	-
53	Common Lineblue	<i>Prosotas nora</i>	+	+	+	+	+	-	-	+	+	+	+	+
54	Tailless Lineblue	<i>Prosotas dubiosa</i>	-	-	-	-	-	-	+	+	+	+	+	+
55	Plains Cupid	<i>Luthrode spandava</i>	+	-	+	+	+	-	+	+	+	+	-	-
56	Small Cupid	<i>Chilades parrhasius</i>	-	+	+	+	-	+	+	+	+	+	-	+
57	Forget Me Not	<i>Catochrysops strabo</i>	-	+	+	+	-	+	+	+	+	+	-	-
58	Gram Blue	<i>Euchrysops cnejus</i>	+	+	+	-	-	-	+	+	+	-	-	-
59	Pea Blue	<i>Lampides boeticus</i>	+	+	+	+	-	-	-	+	+	+	+	+
60	Grass Jewel	<i>Chilades trochylus</i>	+	+	-	-	-	-	-	+	+	+	-	-
61	Common Guava Blue	<i>Virachola isocrates</i>	-	-	-	-	-	-	-	+	-	-	-	-
	Papilionidae: (10)													
62	Common Mormon	<i>Papilio polytes</i>	+	+	+	+	+	+	+	+	+	+	+	+
63	Blue Mormon	<i>Papilio polymnestor</i>	+	+	-	-	-	-	-	-	-	-	-	+
64	Common Lime	<i>Papilio demoleus</i>	+	+	+	+	+	+	+	+	+	+	+	+
65	Common Mime	<i>Papilio clytia</i>	+	-	-	-	-	-	+	-	-	-	-	+
66	Common Rose	<i>Pachliopta aristolochiae</i>	-	-	+	+	-	+	+	+	+	+	+	+
67	Crimson Rose	<i>Pachliopta hector</i>	+	+	-	-	-	+	+	+	+	+	-	+
68	Common Jay	<i>Graphium doson</i>	+	-	-	+	-	+	+	+	+	+	-	-
69	Spot Swordtail	<i>Graphium nomius</i>	-	-	-	-	+	+	+	-	-	-	-	-
70	Tailed jay	<i>Graphium agamemnon</i>	+	+	+	-	+	-	+	+	+	+	+	+
71	Narrow-banded Bluebottle	<i>Graphium tereon</i>	-	-	-	-	-	-	-	-	+	+	+	+
	Hesperiidae: (9)													
72	Grass Demon	<i>Udaspes folus</i>	+	+	-	-	-	-	-	-	-	+	+	+
73	Small Branded Swift	<i>Pelopidas mathias</i>	+	+	+	+	-	-	-	+	+	+	+	+
74	Rice Swift	<i>Borbo cinnara</i>	+	+	-	-	-	-	-	-	+	+	+	+
75	Common Banded Awl	<i>Hasora chromus</i>	+	+	-	+	-	-	-	-	+	+	-	-
76	Common Grass Dart	<i>Taractrocera maevius</i>	+	+	+	-	-	-	-	-	+	+	+	+
77	Common Redeye	<i>Matapa aria</i>	+	+	-	-	-	-	-	-	-	-	-	-

78	Indian Grizzled Skipper	<i>Spialia galba</i>	+	+	+	-	-	-	-	+	+	+	+	+
79	African Marbled Skipper	<i>Gomalia elma</i>	-	-	+	+	-	-	-	+	+	+	+	+
80	Indian Palm Bob	<i>Suastus gremius</i>	+	+	-	-	-	-	-	-	-	-	-	-

+ indicates presence; - indicates absence

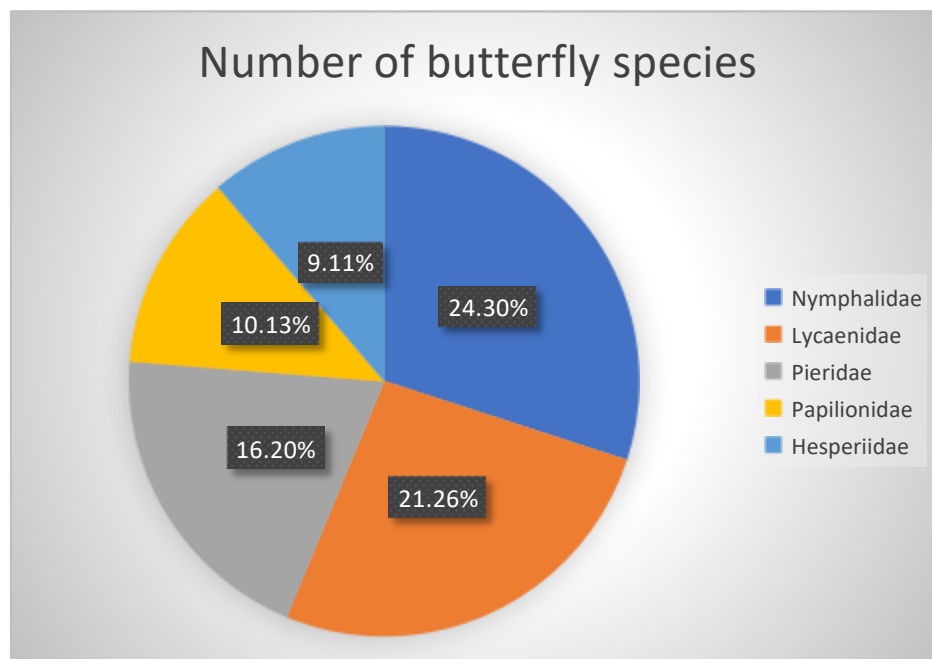


Fig. 2: Distribution of species in the five different families of Butterflies.

for nine months. Nine species of butterflies such as *Danaus chrysippus*, *Euploea core*, *Acraea terpsicore*, *Catopsilia pomona* (Common emigrant and Lemon emigrant), *Eurema hecabe*, *Colotis amata*, *Jamides celeno*, *Papilio polytes* and *Papilio demoleus* were sighted for twelve months. No single species was sighted for eleven months. Nine species of butterflies such as *Catopsilia pyranthe*, *Pareronia hippia*, *Leptosia nina*, *Jamides bochus*, *Zizina otis*, *Zizina karsandra*, *Zizula hylax*, *Prosotas nora* and *Graphium agamemnon* were sighted for ten months. Six species of butterflies such as *Tirumala aglea*, *Junonia orithya*, *Junonia hierta*, *Elymnias caudata*, *Matapa aria* and *Suastus gremius* were sighted for 2 months. Two species of butterflies such as *Euthalia aconthea* and *Virachola isocrates* species were sighted only once, which is considered as a very rare species (Table 1).

Figure 4 depicts the variations in the number of species of butterflies observed during the different months. It is interesting to note that the graph shows two peaks (bimodal); one in September with highest number of species (62) followed by October (58) and the other in February month (56). Both these are 'transitional' months. February is transitional between the wet and dry season whereas September is transitional between the dry and wet season. Kunte (2000); Thangapandian *et al.* (2014); and Jeyaprabha and Mohideen (2017) have reported that large number of butterflies were seen during the months of January and February. Kalaivani and Gunasekaran (2017) and Nair *et al.* (2014) have also revealed that butterfly diversity varies with season and are abundant only for few months and rare or absent during other months of the year. Highest

Table 2: Larval host and nectar plants of different butterfly species at Adyar Eco park region recorded from January 2021- December 2022

S. No.	Family and Butterfly Species	Host plants	Nectar plant
	Nymphalidae:		
1	Plain Tiger, Blue Tiger, Striped Tiger, Dark Blue Tiger, Glassy tiger, Danaid Eggfly, Great Eggfly	<i>Calotrophis</i> spp., <i>Asclepias currassavica</i> , <i>Ficus</i> spp., <i>Crotalaria</i> spp., <i>Sida</i> spp., <i>Sida rhombifolia</i> , <i>Sida cordifolia</i> , <i>Asystasia</i> spp., <i>Asystasiagangetica</i> spp., <i>Abutilon</i> spp., <i>Alternanthera</i> spp., <i>Alternanthera sessilis</i>	<i>Tridax procumbens</i> , <i>Asystasia gangetica</i> , <i>Cyanthillium cenerium</i> , <i>Premna serratifolia/latifolia</i> , <i>Water ipomea aquatica</i> , <i>Lantana camara</i> , <i>Solanum</i> spp., <i>Solanum muricatum</i>
2	Blue Pansy, Chocolate Pansy, Grey Pansy, Lemon Pansy, Peacock Pansy, Yellow Pansy, Tawny Coster	<i>Ruellia</i> spp., <i>Ruellia tuberosa</i> , <i>Justicia</i> spp., <i>Justicia procumbens</i> , <i>Asystasia</i> spp., <i>Asystasiagangetica</i> , <i>Alternanthera</i> spp., <i>Alternanthera philoxeroides</i> , <i>Alternanthera sessilis</i> , <i>Sida</i> spp., <i>Sida rhombifolia</i> , <i>Prosopis juliflora</i> , <i>Passiflora</i> spp., <i>Turnera subulata</i> , <i>Turnera ulmifolia</i>	<i>Psidium guajava</i> , <i>Clitorea ternatea</i> , <i>Tridax procumbens</i> , <i>Asystasia</i> spp., <i>Asystasia gangetica</i> , <i>Leucas aspera</i>
3	Common Crow, Double Branded Crow	<i>Calotrophis</i> spp., <i>Calotrophis gigantia</i> , <i>Asclepias currassavica</i> , <i>Ficus</i> spp., <i>Ficus racemose</i>	<i>Tridax procumbens</i> , <i>Premna serratifolia/latifolia</i>
4	Common Castor, Angled Castor, Common Sailor, Common Palmfly, Tailed Palmfly, Common Leopard, Common Baron, Common Evening Brown	<i>Ricinus communis</i> , <i>Helicteres isora</i> , <i>Calamus</i> spp., <i>Calamus rotang</i> , <i>Tridax procumbens</i> , <i>Flacourtia</i> spp., <i>Flacourtia indica</i> , <i>Mangifera indica</i> , <i>Streblus asper</i> , <i>Cynodon</i> spp.	<i>Lantana camara</i>
	Lycaenidae:		
5	Common Cerulean, Dark Cerulean, Metallic Cerulean, Common Pierrot, Indian Sunbeam, Forget Me Not, Plains Cupid, Small Cupid, Common Guava Blue	<i>Abrus precatorius</i> , <i>Pongamia pinnata</i> , <i>Crotalaria</i> spp., <i>Crotalaria verrucosa</i> , <i>Ziziphus</i> spp., <i>Ziziphus mauritiana</i> , <i>Ziziphus oenopolia</i> , <i>Derris</i> spp., <i>Derris scandens</i> , <i>Tephrosia purpurea</i> , <i>Acacia</i> spp., <i>Acacia nilotica</i> , <i>Strychnos nux-vomica</i> , <i>Psidium guajava</i> , <i>Limonia acidissima</i>	<i>Tridax procumbens</i> , <i>Asystasia gangetica</i> , <i>Passiflora</i> spp.,
6	Lime Blue, Zebra Blue, Gram Blue, Pale Grass Blue, Lesser Grass Blue, Dark Grass Blue, Tiny Grass Blue, Common Line Blue, Tailless lineblue, Grass Jewel, Pea blue, African Babul Blue	<i>Limonia acidissima</i> , <i>Citrus</i> spp., <i>Chloroxylon swietenia</i> , <i>Albizia</i> spp., <i>Albizia lebbeck</i> , <i>Indigofera</i> spp., <i>Abrus precatorius</i> , <i>Acacia</i> spp., <i>Acacia nilotica</i> , <i>Tephrosia</i> spp., <i>Tephrosia purpurea</i> , <i>Amaranthus</i> spp., <i>Amaranthus spinosus</i> , <i>Amaranthus viridis</i> , <i>Ruellia</i> spp., <i>Ruellia tuberosa</i> , <i>Pithecellobium dulce</i> , <i>Allophyllus cobbe</i> , <i>Crotalaria</i> spp., <i>Crotalaria hebecarpa</i> , <i>Pongamia pinnata</i>	<i>Tridax procumbens</i> , <i>Clitorea ternatea</i>
	Pieridae:		
7	Common Emigrant/ Lemon emigrant, Mottled Emigrant, Common Wanderer, Common Albatross, Striped Albatross, Common Gull, Common Jezebel, Psyche	<i>Cassia</i> spp., <i>Cassia fistula</i> , <i>Senna</i> spp., <i>Senna alata</i> , <i>Senna occidentalis</i> , <i>Capparis</i> spp., <i>Capparis zeylanica</i> , <i>Capparis sepiaria</i> , <i>Dryptes</i> spp., <i>Dryptes oblongifolia</i> , <i>Cadaba</i> spp., <i>Cadaba fructosa/trifoliata</i> , <i>Maeura oblongifolia</i> , <i>Pterospermum</i> spp., <i>Pterospermum acerifolium</i> , <i>Cleome</i> spp., <i>Cleome viscosa</i>	<i>Morinda tinctoria/citrifolia</i> , <i>Lantana camara</i> , <i>Tridax procumbens</i> , <i>Asystasia gangetica</i> , <i>Ixora</i> spp., <i>Water ipomea aquatica</i>
8	Common Grass Yellow, Small Grass Yellow, Great Orange Tip, Small Orange Tip, Yellow Orange Tip, Crimson Tip, Small Salmon Arab, Large Salmon Arab	<i>Acacia</i> spp., <i>Cassia</i> spp., <i>Cassia fistula</i> , <i>Pithecellobium dulce</i> , <i>Capparis</i> spp., <i>Capparis zeylanica</i> , <i>Cadaba</i> spp., <i>Maeura oblongifolia</i> , <i>Salvadora</i> spp., <i>Salvadora persica</i>	<i>Tridax procumbens</i> , <i>Alternanthera</i> spp., <i>Morinda tinctoria/citrifolia</i> , <i>Asystasia gangetica</i> , <i>Passiflora</i> spp., <i>Azadirachta indica</i> , <i>Clitorea ternatea</i> , <i>Lantana camara</i>

	Papilionidae:		
9	Common Mormon, Blue Mormon, Common Rose, Crimson Rose, Common Jay, Tailed Jay, Common Lime, Common Mime, Narrow banded Bluebottle, Spot Swordtail	<i>Citrus spp., Murraya spp., Murraya koenigii, Citrus maxima, Clausena spp., Polyalthia spp., Polyalthia suberosa, Polyalthia longifolia, Chloroxylon swietenia</i>	<i>Lantana camara, Ixora spp., Asystasia spp., Asystasia gangetica, Passiflora spp., Turnera spp., Bougainvillea, Clitoria ternatea, Morinda citrifolia/tinctoria, Tridax procumbens, Wrightia tinctoria</i>
	Hesperiidae:		
10	Grass Demon, Small Branded Swift, Rice Swift, Common Grass Dart, Common Banded Awl, Indian Grizzled Skipper, African Marbled Skipper, Common Redeye, Indian Palm Bob	<i>Cymbopogon spp., Cymbopogon citriatus, Grass spp., Pongamia pinnata, Ricinus communis, Derris scandens, Sida spp., Walteria indica, Abutilon spp., Abutilon indicum, Calamus rotang, Psidium guajava</i>	<i>Asystasia spp., Asystasia gangetica, Passiflora spp., Lantana camara, Tridax procumbens, Alternanthera spp., Alternanthera sessilis, Rhinacanthus nastulus</i>

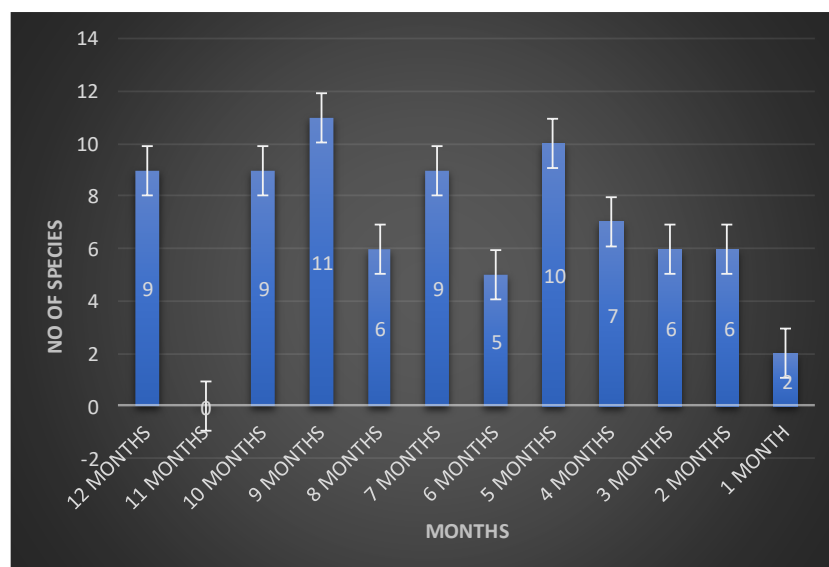


Fig. 3: Frequency distribution of observed butterfly species.

abundance of butterflies peaked during post-monsoon (late August to October) due to the availability of more larval host, adult nectar plants and high flower density (Murugesan and Muthusamy, 2011). May month had the least number of species (22). Evangeline and Santhi (2018) have also reported that few species alone were sighted during the month of May. This is not surprising as May is the driest and hottest month in Chennai with day temperatures of around 40°C or more. Eventhough flowers bloom during May month there is a decline in the number of species, this is, because of the extreme hot weather that leads to habitat destruction and fragmentation. Islam *et al.* (2013) reported that the butterfly diversity is significantly affected by

various biotic and abiotic factors such as temperature, relative humidity, rainfall, and photoperiod. Butterflies experience threats including habitat loss, climate change, diseases, and invasive plants. The above reasons could throw light for a smaller number of butterfly species that occurs in less numbers during specific months. According to Arun (2003), butterfly abundance occurs less during the monsoon season.

The city of Chennai, despite being highly urbanized is known to have a remarkable diversity of butterflies. Nagarajan and Theivaprakasham (2020) reported that there are at least 153 species of butterflies from Chennai, India. This accounts to nearly half of the 330 species of butterflies known

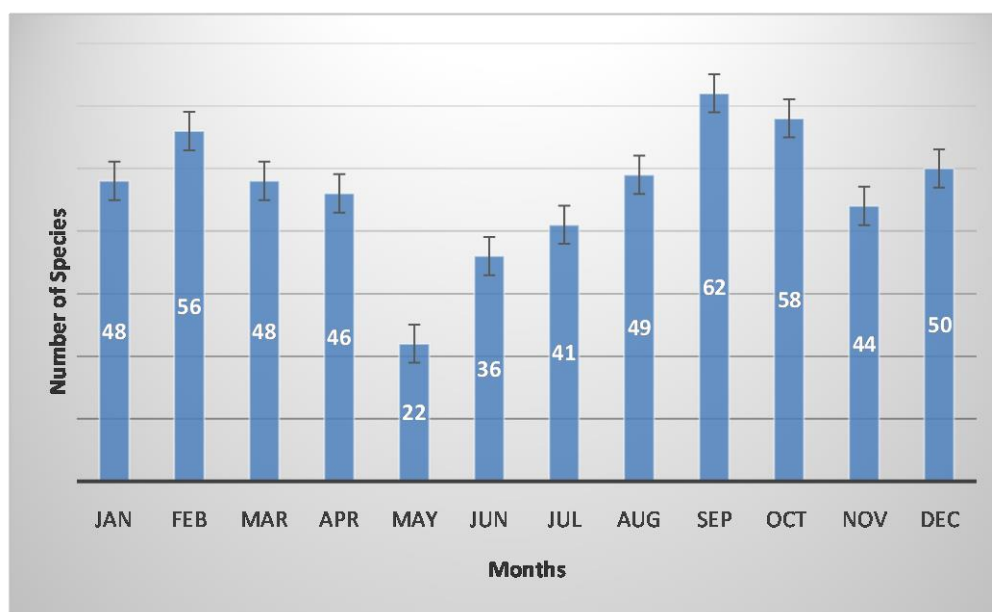


Fig. 4: Monthly variations observed in the number of species of butterflies.

from the state of Tamil Nadu, India. The 80 species observed during the present study are more than half of all the species known from the city of Chennai. Some of the Common butterfly species includes *Euploea core*, *Catopsilia pomona* and *Jamides celeno*. Rare butterfly species includes *Appias albina*, *Hasora chromus* and *Matapa aria*. In this study area, *Colotis fausta* is recorded as a least common species for 3 months. *Elymnias hypermnestra* is recorded as an occasional species, *Elymnias caudata* and *Jamides alecto* were recorded, identified and photo-documented which are very rarely found during their respective months based upon the sightings. Pansies such as *Junonia orithya*, *Junonia hierta*, and *Junonia almanac* are mostly sighted as a rare and occasional species because they are sighted only at the open grounded areas. *Papilio polymnestor*, large swallowtail butterfly is considered as a very rare species due to its very active flight. Whenever seasonal occurrence happens, this species visits the nectar plants. This species was sighted once in December 2021 and again during January and February 2022. In this study region, herbs are present at large numbers followed by lianas, shrubs, trees etc. such that butterflies are attracted to this type of vegetation for its life

forms. Jeyaprabha and Mohideen (2017) have reported that there is a direct relationship between vegetation diversity and butterfly diversity as butterflies are good pollinators. Survival of butterflies depends upon the abundance of nectarine flowering plants. Adult butterflies are attracted by the nectar food plants due to their abundance and diversity. In the present study area, maximum butterfly species is mainly associated with plant species such as *Ixora spp.*, *Premna serratifolia/latifolia*, *Morinda tinctoria/citrifolia*, *Tridax procumbens*, *Calotropis spp.*, *Asystasia spp.*, and *Bougainvillae*. Flowering season of *Ixora* is during summer, many butterfly species derives most of their heat from the sun. Moreover, Duara and Kalita (2014) have reported that *Ixora* plant contains phytochemicals such as lupeol, ursolic acid, oleanolic acid, sitosterol, rutin and quercetin etc., hence the adult butterfly's sucks nectar for their pollination process. *Morinda tinctoria/citrifolia* plant also attracts butterflies of Nymphalidae and Papilionidae families due to their secondary metabolites, whereas *Ixora* plant attracts most of the butterfly species for its nectar during summer. *Premna serratifolia/latifolia* plant also attracts many butterfly species during flowering season from April, May, June and

November. The diversity of butterflies is influenced by the presence of vegetation where the butterflies can find nectar as a source of food and the butterfly species can lay their eggs on the flowers and leaves for growth. The survival of butterflies has become more dominant in a particular habitat at different sites in Adyar Eco park region due to the cool climate, increased moisture content, sunshine availability of water, extensive plantation of larval host and adult nectar plants. Hence, the dense vegetation at Adyar Eco park is emerging as a habitat with the potential to support rich biodiversity.

Conclusion

Butterfly diversity can be used as a reliable yardstick for monitoring biodiversity in a variety of terrestrial habitats. The present study has revealed remarkable diversity of butterflies in a re-vegetated urban habitat. Some of the interesting patterns observed such as the bimodal distribution of butterflies across the twelve months need further study. Continuous monitoring of butterfly species diversity in the Adyar Eco park will reveal if there are any changes in the local ecosystem and in Chennai. Such research will have wider applications in understanding and mitigating the impacts of climate change in urban areas.

Ethical Statement

No animals have been sacrificed for this study, hence Ethical Approval not required.

Author Contributions

Brindha A.: Data curation, Formal analysis, Investigation, Methodology, Writing-original draft, Writing- review and editing; *Bavani Govindarajulu*: Supervision, Validation, Writing-review and editing. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest

The authors declare that they have no conflicts of interest to disclose.

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