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Influence of climate change in urban butterfly diversity of Guindy National Park in Chennai, Tamil Nadu, India

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Abstract
Guindy National park with its unique vegetation has recorded 99 butterfly species. Lycaenidae documented the highest number of species (31 species) followed by Nymphalidae (27 species) and Pieridae (19 species), Hesperiidae and Papilioniae (11 species). The butterfly status of presence and absence were recorded as Common (C), Occasional (O), Rare(R) and Very Rare (VR) where common species (43.4%) were higher followed by occasional (21.2%), Rare (19.2%) and very rare (16.2%). Climatic parameters with diversity of butterfly species were studied. The least number of species (1.81%) was recorded at minimum temperature (28˚C) while at maximum temperature (34˚C) 3.54% species were recorded. At average temperature (33˚C) maximum number of species (17.45%) was recorded. Decrease in species richness was noted at maximum amount of rainfall (194.2 mm - 261.15 mm) and minimum rainfall (0.1 mm - 17.6 mm). Moderate rainfall (73.08 mm) showed maximum species. Seven species of butterflies comes under schedule species according to Indian Wildlife (Protection) Act 1972.

Keywords: butterfly diversity, schedule species, environmental variation, climatic parameters

1. Introduction
In recent decade natural calamity in well developed cities are glimpsing frequently due to growing urbanization combined with carbon emission and global warming [1]. Chennai is one of the urbanized mega metropolitan cities facing a bigger climate change. Extreme landscape change from plantations to apartments and industries are slowly chocking the survival of butterflies in Chennai. Guindy National park is the only last Coromandel - Circar coastal plains in the northeastern Tamil Nadu sheltering the indigenous flora and fauna. Butterflies form a very important component of biodiversity being good pollinators [2, 3]. They are sensitive insects which react quickly to any kind of disturbance like changes in the habitat quality, environmental variation [4, 5, 6, 7]. No attention has been made on habitat loss and fragmentation of butterflies [8]. Notably these beautiful insects are slowly disappeared due to changes in climate, land pattern and habitat as they are closely dependent on plants [9, 10]. The butterflies' conservation lies in ensuring the proper functioning of the ecosystems and their ability to enhance services to humans and dependent living organisms that comprise the must to bring back greenery in metropolitan cities [11]. The aim of the study is to monitor the seasonal wise diversity of butterflies and environmental parameters in the urban forest and also to enhance necessary information on protection and conservation of butterfly species in the city zones.

2. Materials and Methods
2.1 Study site
Extensive study was carried out in Guindy National Park which is situated inside the city covering an area of 2.70 km^2 (13° 0' 29" N, 80° 13' 9" E). Guindy National Park is the last remnants natural habitat of Coromandel circar coastal plain in the northeastern Tamil Nadu. The vegetation type of the park is Scrub Jungle Tropical Dry Ever Green Forest [12]. Guindy National Park has a typical dissymmetric climate and the temperature ranges from maximum 32.9˚C to minimum 24.3˚C and the annual rainfall received is 1,215 mm. There are about 350 species of plants, 14 species of mammals and more than 150 species of birds recorded from literature and unpublished documentation from forest department.

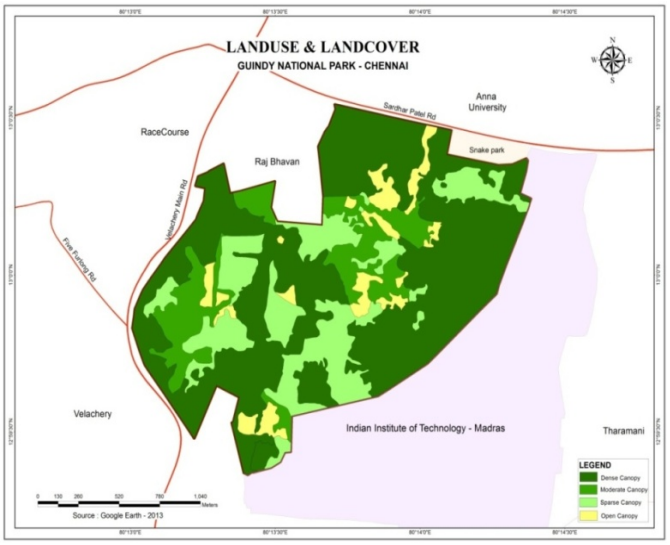

Fig 1: Map showing Guindy National Park located in Chennai city, Tamil Nadu, India.

2.2 Survey Method
The butterfly survey was conducted for a period of eleven months from February 2016 – December 2016 at Guindy

National Park. Line transact method [13] was carried out total of 11 line transects of 200 m were surveyed. The survey was done once in a week from 7am to 1pm and 3pm to 5pm. Photographic documentation was done using DSLR camera D5600 Nikon attached with 18-55 mm and 70-300 mm lens. Identification, classification of butterfly species and scientific names was done using Field guide [14] and available literatures [15, 16]. Butterflies which were difficult to identify were caught using hand net, photographed and then through expert the butterflies were identified. Environmental parameters such as temperature, humidity, rain fall and wind speed data were also recorded [17].

2.3 Data Analysis

Butterfly species were segregated and categorized as Common (C) (< 50 sightings), Occasional (O) (15-49 sightings), Rare (R) (2-14 sightings) and Very Rare (VR) (1 sightings) based on the number of sightings [18]. Graphical representation of butterfly family, sub family, presence absence status and climatic factor such as temperature, humidity and rainfall graphs was plotted. The diversity indices were calculated using Simpson's Index $D = \Sigma n(n-1)/N(N-1)$ or $D = \Sigma(n/N)^2$ where n = the total number of organisms of a particular species, N = the total number of organisms of all species. The D value range is 0 and 1 where 0 represents infinite diversity whereas 1 represents no diversity that is bigger the value of D, the lower the diversity. Relative abundance was calculated using Shannon - Wiener diversity index $H = -\text{sum}(P_i \ln[P_i])$ which states the number of species within site with the relative abundance of each species where Sum = summation and pi = proportion of the i^{th} species in the total sample. Evenness of the species was done using Evenness Index E= H/ lnS where H = index of diversity lnS = total number of species. Equitability assumes a value between 0 and 1 with 1 being complete evenness and Species Richness was also tabulated which represents the number of species per sample is a measure of richness [19]. The more species present in a sample, the 'richer' the sample [20].

3. Results

The study revealed a total of 99 species of butterflies belonging to 5 families and 17 sub families. Family wise diversity of butterfly was dominated by Lycaenidae (31.4%) followed by Nymphalidae (27.3%), Peridae (19.1%), Papilionidae (11.1%) and Hesperiidae (11.1%) (Fig. 2).

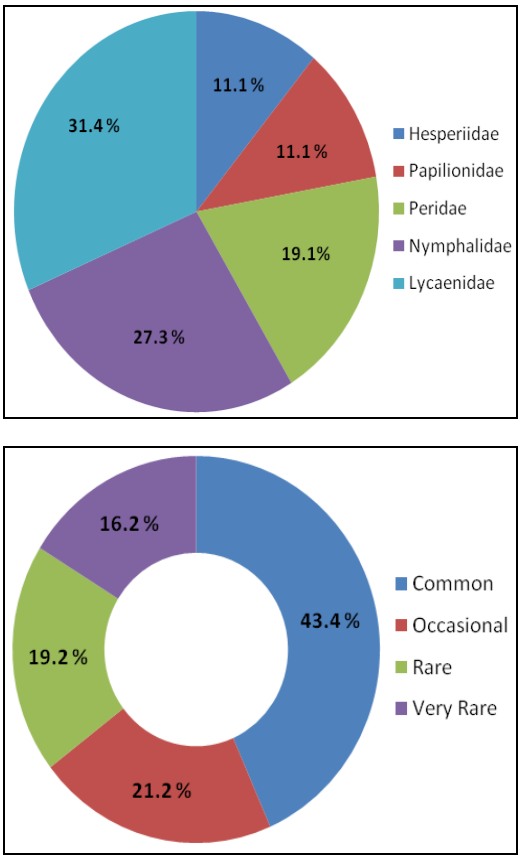

Fig 2&3: Percentage of Butterfly Family and Status observed in Guindy National Park from February 2016 to December 2016

The percentage of butterfly status was rated as Common (C), Occasional (O), Rare (R), and Very Rare (VR). The occurrence of Common species was more (43.4%) than Occasional (21.2%), Rare (19.2%) and Very Rare (16.2%) (Fig.3). Out of 17 Sub families Polyommatinae (24) showed maximum species of butterflies followed by Pierinae (15), Papilioninae (11), Nymphalinae (9), Danainae (8), Theclinae and Hesperiinae (5), Coliadinae (4), Pyrginae, Coeliadinae and Satyrinae (3), Biblidinae, Heliconiinae and Limenitinae (2) and single species was recorded from Miletinae, Curtinae Sunbeam and Charaxinae (Fig.4).

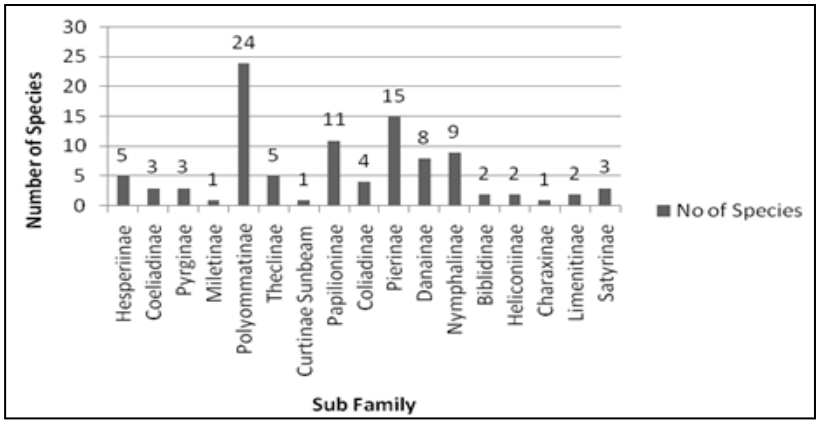

Fig 4: Butterfly species observed in each Sub family recorded in Guindy National Park from February to December 2016.

Table 1: Checklist of butterfly species observed in Guindy National Park from February 2016 - December 2016

S. no	Common Name	Scientific Name	Common	Occasional	Rare	Very Rare
I. Hesperiidae						
1	African Marbled Skipper	*Gomalia elma* (Trimen)				Very rare
2	Brown Awl	*Badamia exclamationis* (Fabricius)		Occasional		
3	Chestnut bob	*Iambrix salsala* (Moore)	Common			
4	Common banded awl	*Hasora chromus* (Cramer)	Common			
5	Dark branded swift	*Peliopedas agna*(Moor)			Rare	
6	Indian palm bob	*Suastus gremius* (Fabricius)	Common			
7	Indian Skipper	*Spialia galba* (Fabricius)			Rare	
8	Rice swift	*Borbo cinnara* (Wallace)				Very rare
9	Straight swift	*Parnara guttatus* (Bremer & Grey)	Common			
10	Tricoloured Flat	*Gomalia elma* (Trimen)			Rare	
11	White Banded Awl	*Hasora taminatus* (Hubner)			Rare	
II. Lycaenidae						
12	African babul blue	*Azanua jesous* (Guerin Meneville)		Occasional		
13	Angled pierroet	*Caleta caleta* (Hewitson)				Very rare
14	Apefly	*Spalgis epius* (Westwood)			Rare	
15	Bright babul blue	*Azanus ubaldus* (Stoll)				Very Rare
16	Common cerulean	*Jamides celeno* (Cramer)	Common			
17	Common guava blue	*Virachola isocrates* (Fabricius)		Occasional		
18	Common pierrot*	*Castalius rosimon* (Fabricius)*	Common			
19	Dark Cerulean	*Jamides bochus* (Stoll)				Very rare
20	Dark grass blue	*Zizeeria karsandra* (Moore)	Common			
21	Gram blue*	*Euchrysops cnejus* (Fabricius)*	Common			
22	Indian Common line blue	*Prosotas nora* (C. Felder)	Common			
23	Indian Red Flash	*Rapala iarbus* (Fabricius)			Rare	
24	Indian sunbeam	*Curetis thetis* (Drury)		Occasional		
25	Indian Tailless line blue	*Prosotas dubiosa indica* (Evans)		Occasional		
26	Indian White tipped line blue	*Prosotas noreia* (C. & R.Felder)				Very rare
27	Large Oak Blue	*Arhopala amantes* (Hewitson)		Occasional		
28	Lesser grass blue	*Zizina otis* (Fabricius)	Common			
29	Lime blue	*Chilades lajus* (Stoll)	Common			
30	Monkey puzzle	*Rathinda amor* (Fabricius)	Common			
31	Opaque Six Line Blue	*Nacaduba beroe* (Felder & Felder)				Very Rare
32	Oriental forget me not	*Catochrysops strabo* (Fabricius)		Occasional		
33	Oriental grass jewel	*Freyeria putli* (Kollar)	Common			
34	Pale grass blue	*Pseudozizeeria maha* (Kollar)		Occasional		
35	Pea Blue *	*Lampides boeticus* (Linnaeus)*			Rare	
36	Plains cupid	*Chilades pandava* (Horsefield)		Occasional		
37	Pointed ciliate blue	*Anthene lycaenina* (Felder)			Rare	
38	Rounded pierroet	*Tarucuc nara* (Kollar)				Very rare
39	Shot silverline	*Spindasis ictis* (Hewitson)				Very rare
40	Small cupid	*Chilades parrhasius* (Fabricius)		Occasional		
41	Tiny grass blue	*Zizula hylax* (Fabricius)	Common			
42	Zebra blue	*Leptotes plinius* (Fabricius)	Common			
III. Papilionidae						
43	Blue Mormon	*Papilio polymnestor* (Cramer)			Rare	
44	Common banded peacock	*Papilio crino*(Fabricius)				Very rare
45	Common jay	*Graphium doson* (C. & R.Felder)		Occasional		
46	Common lime butterfly	*Papilio demoleus* (Linnaeus)	Common			
47	Common Mime	*Chilasa clytia* (Linnaeus)				Very rare
48	Common Mormon	*Papilio polytes* (Linnaeus)	Common			
49	Common rose	*Pachiliopta aristolochiae* (Linnaeus)		Occasional		
50	Crimson rose*	*Pachliopta hector* (Fabricius)*	Common			
51	Narrow banded blue bottle	*Graphium teredon* (Felder)				Very rare
52	Spot sword tail	*Graphium nomius* (Esper)			Rare	
53	Tailed jay	*Graphium chironides* (Honrath)	Common			
IV. Peridae						
54	Asian cabbage white	*Pieris canidia indica* (Evans)				Very rare
55	Chocolate Albatross	*Appias lyncida* (Cramer)				Very rare
56	Common albatross*	*Appias albina* (Boisduval)*			Rare	
57	Common emigrant	*Catopsilia pomona* (Fabricius)	Common			

58	Common grass yellow	*Graphium Sarpedon* (Linnaeus)	Common			
59	Common gull	*Cepora nerissa* (Fabricius)	Common			
60	Crimson Tip	*Colotis danae* (Fabricius)			Rare	
61	Great Orange Tip	*Hebomoia glaucippe* (Linnaeus)			Rare	
62	Large Salmon Arab	*Colotis fausta* (Oliver)				Very rare
63	Mottled emigrant	*Catopsilia pyranthe* (Linnaeus)	Common			
64	Pioneer	*Belenois aurota* (Fabricius)		Occasional		
65	Plain Orange Tip	*Colotis eucharis* (Fabricius)			Rare	
66	Psyche	*Leptosia nina* (Fabricius)	Common			
67	Small grass yellow	*Eurema brigitta* (Cramer)	Common			
68	Small salmon Arab	*Colotis amata* (Fabricius)		Occasional		
69	Striped albatross	*Appias libythea* (Fabricius)			Rare	
70	White Orange Tip	*Ixias marianne* (Cramer)				Very rare
71	Yellow orange tip	*Ixias pyrene* (Linnaeus)	Common			
V. Nymphalidae						
72	Angled castor	*Ariadne ariadne* (Linnaeus)	Common			
73	Black rajah	*Charaxes solon* (Fabricius)		Occasional		
74	Blue pansy	*Junonia orithiya* (Linnaeus)	Common			
75	Blue tiger	*Tirumala limniace* (Cramer)	Common			
76	Brown king crow	*Euploea klugii* (Moore)			Rare	
77	Chestnut streaked sailer	*Neptis jumbah* (Moore)	Common			
78	Chocolate pansy	*Junonia iphita* (Cramer)	Common			
79	Common bush brown	*Mycalesis perseus* (Fabricius)	Common			
80	Common crow*	*Euploea core* (Cramer)*	Common			
81	Common evening brown	*Melanitis leda* (Linnaeus)	Common			
82	Common leopard	*Phalanta phalantha* (Drury)	Common			
83	Common sailer	*Neptis hylas* (Linnaeus)	Common			
84	Common Wanderer	*Colotis amata* (Fabricius)	Common			
85	Dannaid eggfly*	*Hypolimnas missippus* (Linnaeus) *	Common			
86	Dark blue tiger	*Tirumala septentrionis* (Butler)		Occasional		
87	Double branded crow	*Euploea Sylvester* (Fabricius)		Occasional		
88	Glassy tiger	*Parantica aglea* (Stoll)			Rare	
89	Great eggfly	*Hypolimnas bolina* (Linnaeus)	Common			
90	Grey Pansy	*Junonia atlites* (Linnaeus)		Occasional		
91	Joker	*Byblia ilithyia* (Drury)			Rare	
92	Lemon pansy	*Junonia lemonias* (Linnaeus)	Common			
93	Painted Lady	*Vanessa cardui* (Linnaeus)			Rare	
94	Peacock pansy	*Junonia almanac* (Linnaeus)		Occasional		
95	Plain tiger	*Danaus chrysippus* (Linnaeus)	Common			
96	Striped tiger	*Danaus genutia* (Cramer)	Common			
97	Tamil bush brown	*Mycalesis subdita* (Moore)		Occasional		
98	Tawny coster	*Acraea violae* (Fabricius)	Common			
99	Yellow pansy	*Junonia hierta* (Fabricius)		Occasional		

Species sighted as Common ranges (< 50), Occasional (15 to 49), Rare (2 to 14) and Very Rare (1). Highlighted with star represents Scheduled species according to Indian wildlife protection Act 1972.

Table 2: List of butterflies with mean and standard error recorded during the study period from February to December 2016 in Guindy National Park.

S. no	Sub Family	Common Name	Mean
I. Hesperiidae			
1	Coeliadinae	Common banded awl	2.90 ± 1.30
2	Coeliadinae	Brown Awl	6.40 ± 1.92
3	Coeliadinae	White Banded Awl	0.09 ± 0.09
4	Hesperiinae	Straight swift	31.91 ± 6.76
5	Hesperiinae	Chestnut bob	9.18 ± 2.81
6	Hesperiinae	Indian palm bob	24.45 ± 4.73
7	Hesperiinae	Dark branded swift	0.09 ± 0.09
8	Hesperiinae	Rice swift	0.18 ± 0.12
9	Pyrginae	Tricoloured Flat	0.09 ± 0.09
10	Pyrginae	African Marbled Skipper	0.54 ± 0.38
11	Pyrginae	Indian Grizzled Skipper	0.18 ± 0.19

II. Lycaenidae			
12	Curtinae Sunbeam	Indian sunbeam	1.36 ± 0.71
13	Miletinae	Apefly	0.09 ± 0.09
14	Polyommatinae	Plains cupid	2.36 ± 0.81
15	Polyommatinae	Small cupid	0.45 ± 0.38
16	Polyommatinae	Gram blue	1.81 ± 0.73
17	Polyommatinae	Dark grass blue	15.63 ± 2.82
18	Polyommatinae	Lesser grass blue	5.72 ± 1.66
19	Polyommatinae	Tiny grass blue	4.54 ± 1.02
20	Polyommatinae	Pale grass blue	3.27 ± 0.90
21	Polyommatinae	Oriental grass jewel	4.00 ± 0.78
22	Polyommatinae	Common pierrot	27.63 ± 4.42
23	Polyommatinae	Rounded pierroet	0.09 ± 0.09
24	Polyommatinae	Angled pierroet	0.09 ± 0.09
25	Polyommatinae	Zebra blue	4.54 ± 1.08
26	Polyommatinae	Oriental forget me not	3.63 ± 1.17
27	Polyommatinae	Common cerulean	35.90 ± 22.91
28	Polyommatinae	Dark Cerulean	3.45 ± 1.71
29	Polyommatinae	Lime blue	97.36 ± 17.60
30	Polyommatinae	Indian Common line blue	1.09 ± 0.35
31	Polyommatinae	Indian Tailless line blue	2.36 ± 1.49
32	Polyommatinae	Indian White tipped line blue	0.09 ± 0.09
33	Polyommatinae	Pointed ciliate blue	0.63 ± 0.35
34	Polyommatinae	African babul blue	0.54 ± 0.32
35	Polyommatinae	Bright babul blue	0.18 ± 0.12
36	Polyommatinae	Pea Blue	0.72 ± 0.31
37	Polyommatinae	Opaque Six Line Blue	0.09 ± 0.09
38	Theclinae	Monkey puzzle	1.09 ± 0.29
39	Theclinae	Indian Red Flash	0.45 ± 0.29
40	Theclinae	Shot silver line	0.09 ± 0.09
41	Theclinae	Common guava blue	0.18 ± 0.19
42	Theclinae	Large Oak Blue	0.72 ± 0.44
III. Papilionidae			
43	Papilioninae	Common rose	8.36 ± 2.52
44	Papilioninae	Crimson rose	20.09 ± 5.81
45	Papilioninae	Common Mormon	97.27 ± 17.61
46	Papilioninae	Blue Mormon	0.09 ± 0.09
47	Papilioninae	Common jay	38.54 ± 9.80
48	Papilioninae	Tailed jay	14.45 ± 3.08
49	Papilioninae	Narrow banded blue bottle	0.45 ± 0.29
50	Papilioninae	Common Mime	0.54 ± 0.29
51	Papilioninae	Common lime butterfly	74.36 ± 10.98
52	Papilioninae	Spot sword tail	7.27 ± 2.49
53	Papilioninae	Common banded peacock	0.09 ± 0.09
IV. Peridae			
54	Coliadinae	Common emigrant	442.18 ± 88.99
55	Coliadinae	Mottled emigrant	17.18 ± 5.53
56	Coliadinae	Common grass yellow	55.72 ± 10.3
57	Coliadinae	Small grass yellow	11.36 ± 3.15
58	Pierinae	Common albatross	0.36 ± 0.21
59	Pierinae	Chocolate Albatross	0.18 ± 0.12
60	Pierinae	Striped albatross	0.18 ± 0.12
61	Pierinae	Psyche	55.18 ± 7.28
62	Pierinae	Yellow orange tip	295.27 ± 77.26
63	Pierinae	Great Orange Tip	2.27 ± 0.89
64	Pierinae	White Orange Tip	1 ± 0.64
65	Pierinae	Plain Orange Tip	0.36 ± 0.25
66	Pierinae	Crimson Tip	0.54 ± 0.38
67	Pierinae	Common gull	50.63 ± 16.61
68	Pierinae	Pioneer	4.18 ± 2.32
69	Pierinae	Asian cabbage white	0.09 ± 0.09
70	Pierinae	Small salmon Arab	0.18 ± 0.19
71	Pierinae	Large Salmon Arab	0.09 ± 0.09

72	Pierinae	Common Wanderer	49.63 ± 12.05
V. Nymphalidae			
73	Biblidinae	Joker	0.09 ± 0.09
74	Biblidinae	Angled castor	13.63 ± 4.45
75	Charaxinae	Black rajah	0.45 ± 0.25
76	Danainae	Common crow	57.9 ± 9.80
77	Danainae	Double branded crow	5.09 ± 1.88
78	Danainae	Brown king crow	1.27 ± 0.61
79	Danainae	Plain tiger	34.9 ± 6.51
80	Danainae	Striped tiger	18.90 ± 5.10
81	Danainae	Blue tiger	47.9 ± 12.38
82	Danainae	Dark blue tiger	8 ± 2.72
83	Danainae	Glassy tiger	0.18 ± 0.19
84	Heliconiinae	Tawny coster	70.81 ± 19.07
85	Heliconiinae	Common leopard	14.09 ± 4.58
86	Limenitinae	Common sailer	2.27 ± 0.86
87	Limenitinae	Chestnut streaked sailer	1.81 ± 0.66
88	Nymphalinae	Painted Lady	0.09 ± 0.09
89	Nymphalinae	Lemon pansy	71.09 ± 20.21
90	Nymphalinae	Chocolate pansy	28.18 ± 6.70
91	Nymphalinae	Peacock pansy	4.27 ± 1.84
92	Nymphalinae	Blue pansy	6 ± 1.57
93	Nymphalinae	Grey Pansy	3.90 ± 1.48
94	Nymphalinae	Yellow pansy	1.09 ± 0.49
95	Nymphalinae	Great eggfly	17.36 ± 4.93
96	Nymphalinae	Dannaid eggfly	10.27 ± 3.70
97	Satyrinae	Common evening brown	12.27 ± 5.38
98	Satyrinae	Common bush brown	2.27 ± 0.70
99	Satyrinae	Tamil bush brown	0.18 ± 0.12

The mean value has varied from species to species. In family Hesperidae greater mean value was observed in *Parnara guttatus* (Bremer and Grey) (31.91) and the least (0.09) in *Gomalia elma* (Trimen), *Peliopedas agna* (Moor) and *Hasora taminatus* (Hubner). *Chilades lajus* (Stoll) belonging to family Lycanidae has shown maximum average of (97.36) and minimum average of (0.09) was noted in *Spalgis epius* (Westwood), *Tarucuc nara* (Kollar), *Caleta caleta* (Hewitson) and *Nacaduba beroe* (Felder and Felder). The average number of species *Papilio polytes* (Linnaeus) was dominated with 97.27 and the least average (0.09) was obtained by *Papilio polymnestor* (Cramer) and *Papilio crino* (Fabricius). The percentage distribution of Peridae species *Catopsilia pomona* (Fabricius) has the greatest mean value (442.18) among all the species and the lowest mean value of 0.09 was observed in *Pieris canidia indica* (Evans) and *Colotis fausta* (Oliver). *Junonia lemonias* (Linnaeus) species of Nymphalidea family recorded the maximum average value of 71.09 and the least value (0.09) was observed in *Vanessa cardui* (Linnaeus) and *Byblia ilithyia* (Drury).

Table 3: Diversity Indices of Butterfly Species Recorded in Guindy National Park from February 2016 – December 2016

Month	Shannon's Weiner Index	Simpson Diversity	Species Richness	Evenness
February	2.91	0.10	7.28	0.63
March	2.85	0.12	8.87	0.62
April	2.48	0.21	5.89	0.54
May	2.18	0.21	3.54	0.47
June	2.94	0.11	12.08	0.64
July	3.05	0.10	14.88	0.66
August	3.31	0.09	17.45	0.72
September	3.18	0.07	8.80	0.69
October	3.08	0.11	11.55	0.67
November	3.08	0.09	7.83	0.67
December	2.97	0.06	1.81	0.65

The diversity indices of butterfly species such as Shannon's Weiner Index, Simpson Index of Diversity, Species Richness and Evenness was computed on month wise from February to December. The diversity was recorded high in the month of August and least in the month of May where very few species were sighted. More number of species richness was sighted in the month of August. The variation of species richness has changed with temperature, rainfall and humidity. The pre monsoon (June-July) and post monsoon (August-November) showed good number of species where as peek summer (May) and winter (December) showed less number of species [21, 22]. Species Richness was maximum during the month of August

(17.45) followed by July (14.88) and was low in the month of December (1.81). Changes in the weather pattern have influenced the changes in the diversity and species richness of butterflies. Maximum temperature, maximum rainfall and wind speed has shown decrease in species richness apparently lower humidity has shown increase in species richness (Fig. 5, 6, 7 and 8).

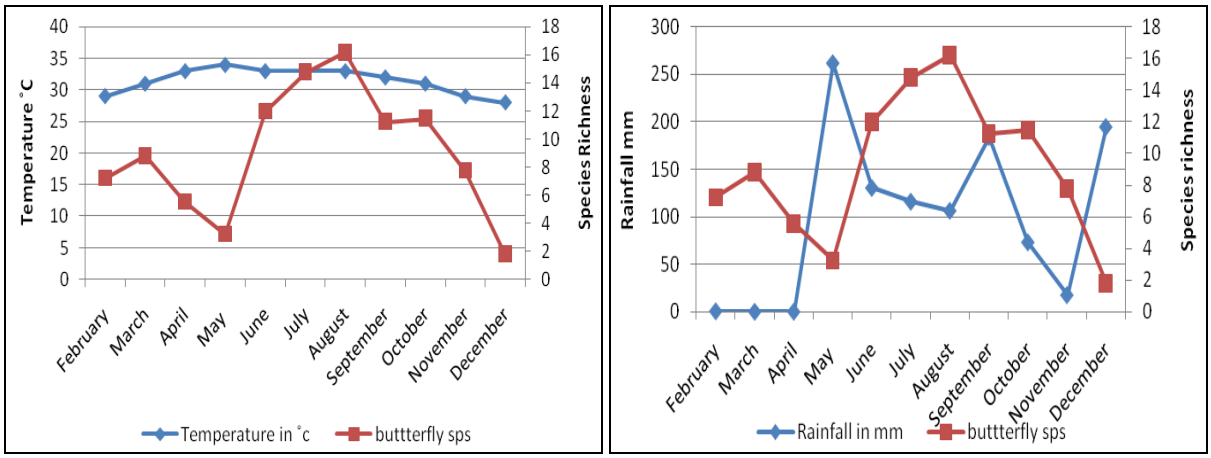

Fig 5&6: Relationship between Species Richness with Temperature and Rainfall recorded in Guindy National Park from February-December 2016.

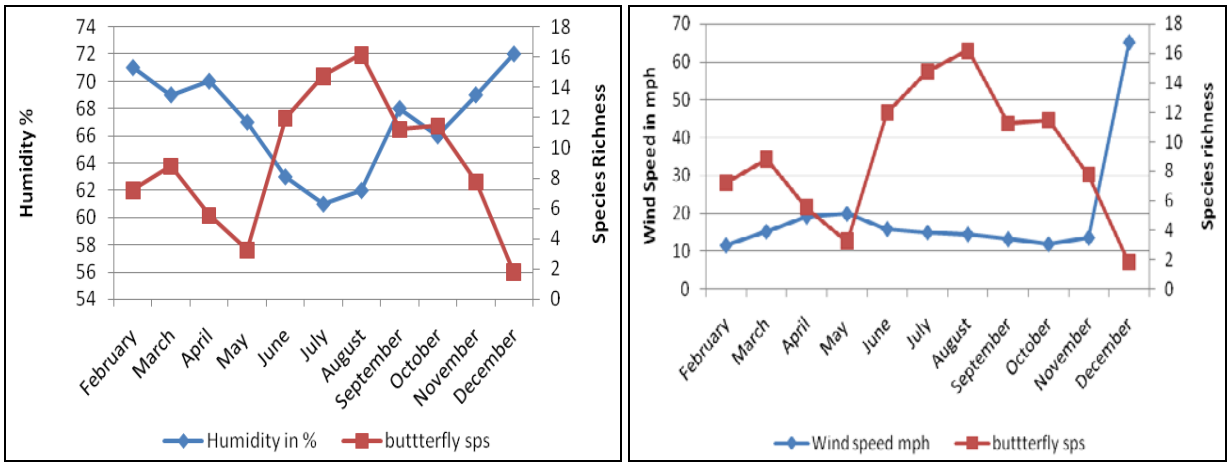

Fig 7&8: Relationship between Species Richness with Humidity and Wind Speed Recorded in Guindy National Park from February-December 2016.

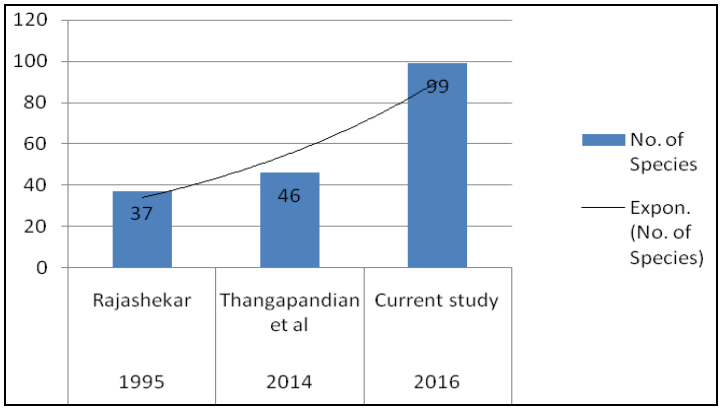

Fig 9: Butterfly Community Recorded during Different Period in Guindy National Park

Very few studies are documented on butterfly diversity in Guindy National Park. In 1995 Rajashekar [23] has recorded 37 species later in 2014 Thangapandian [24] has observed 46 species and the current study reveals 99 species of butterflies. Comparing the diversity from 1995 to 2016 the diversity of butterfly has increased rapidly in urban region though the

forest dwells in metropolitan city. Changes in Climate and migration are possible reasons for the increase in diversity.

4. Discussion

Butterfly species encounter a vast temporal and spatial variability in the natural conditions [25]. Lepidopterons are the key indicator of climate change [26, 27, 28, 29]. In urban cities maintenance of local biodiversity is an important factor [30]. Habitat loss and disturbance causes decline in the population [31,32,33].To protect the declining diversity of butterflies, Indian Wildlife Protection Act have enlisted 452 species of butterflies as Scheduled species under Wildlife Protection Act 1972 [34]. In the present study seven species of butterflies comes under wildlife protection Act, similar Scheduled species have been recorded in Melghat forest zone Maharastra, India [35, 36]. Impacts of the anthropogenic climate change have been documented on all continents, in all oceans, and in all most major taxonomic groups [37, 38, 39]. Butterfly species presence and absence vary in different seasons and more diversity appears in post monsoon [40, 41]. Climatic factors such as humidity, rainfall, temperature and wind speed influence the activity of butterfly in terms of seasonal reproduction and dormancy [42, 43 and 44]. The monsoon rain in the month of June, July and August was moderate (103.15 mm – 106.15 mm) where more number of butterfly species were encountered. High rainfall as summer rain in the month of May (261.15 mm) and Vardha cyclone in the month of December (194.2 mm) has recorded the least species occurrence. Similarly the wind speed in the month of December (65 mph) due to cyclone has greatly affected the butterfly species. The aftermath effects of cyclone have destroyed the vegetation. Butterflies are seasonal in nature the winter butterflies have rarely occurred due to cyclones in the month of December which has shown low diversity. The drop in diversity due to extreme climate has not favored presence of butterflies. June to August and November to first week of December are the best time to encounter more number of species [45]. Butterfly tends to avoid low temperature, local migration or hibernation takes place [46, 47]. Study on climatic factor affecting butterfly diversity is currently necessary to document on a large scale to protect the species from extinction. Climatic factor have been influencing the diversity of butterflies in terms of abundance and species richness [48, 49]. High temperature and precipitation have changed over a past period of time frequent drought has witnessed across the country [50]. The hottest month May with 34˚C has the lowest species diversity and lowest temperature 28˚C has the least diversity. Humidity ranging from 61%-63% in June, July and August has favored more number of species where as high humidity range from 67%-72% recorded low diversity of butterfly in the month of February, May and December (72%) [51]. The drop in diversity due to extreme climate has not favored presence of butterflies. June to August and November to first week of December are the best time to encounter more number of species in Guindy National park Changes as climate have started to shift the season pattern of butterflies.

5. Conclusion

From the findings it is evident that the climate change in urban zone is affecting the diversity of the butterflies. The result gives a caution that the indigenous species of butterflies are at the urge of deterioration. Butterfly fauna around us play a great deal in maintaining the ecosystem. Thus it is a great essence to maintain the existing habitat, establishing eco friendly gardens and butterfly garden as an alternative method to protect and conserve the butterfly species in urban cities.

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