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The butterfly diversity in an open forest in bangalore-urban

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Abstract
The diversity of butterflies of Doresanipalya forest was studied from April 2018 to November 2018 by line-transect method. During pre-monsoon, monsoon and post-monsoon a total of 68 species under 47 genera of six families; *viz*., Papilionoidea, Pieridae, Nymphalidae, Riodinidae, Lycaenidae and Hesperiidea were recorded. Of these family Nymphalidae accounted for 35% (24 species) of the total species count followed by Lycaenidae (17 species), Hesperiidae (10 species), Papilionoidea (8 species), Pieridae (8 species) and Riodinidae (1 species). Species richness was highest in the post-monsoon, with a total of 60 species. The diversity indices such as Shannon-Weiner diversity index, Shannon Evenness index and Simpsons diversity index were calculated.

Keywords: butterflies, diversity, doresanipalya forest, lepidoptera, line transect

1. Introduction
The greater part of the world's diversity consists of insects. They represent about 50% of the world's biodiversity [1]. Insect study is difficult because they are the most species-rich yet the least known [2]. For quite a while, butterflies constantly mesmerized the mankind with its beauty [3]. They are the most well-known and the most contemplated group of insects. There is no other group of insects that are more fascinating than the butterflies. Their bright colours and delicate flapping movements; the beauty and the variety, always appeals the eyes of the observer [4]. They increase the aesthetic value and their size ranges from the small blues to the large birdwings [5, 6, 7].

Butterflies are studied to monitor the changes in climate and are very sensitive to temperature, humidity, habitat disturbances and the light levels [8]. Butterflies like other birds and animals are studied as ecological indicators and assume a critical role in both ecological and economic benefits for the human beings [9]. They are one of the important food chain components for the birds and other predatory animals and they also help in pollination when they move from one plant to another while collecting nectar [10, 11, 12, 13]. Most of the butterflies are seasonal and prefer a particular type of habitat. The main objective of the study was to gain knowledge on the diversity and seasonal variation of the butterflies in the Doresanipalya reserve forest. It also aimed at gathering information on population fluctuation in the area and the reason for the same.

2. Materials and Methods
Doresanipalya forest is also known as JP Nagar Reserve Forest, is a 35-hectare patch of forest. The latitude and longitude of the forest are 12.972442, 77.580643 respectively. The mean temperature in the pre-monsoon was 34˚C, 26˚C in the monsoon and 32˚C in the post-monsoon. The precipitation value ranged from 3.37mm to 6.69mm, humidity ranging from 53% to 78%. The reserve forest is lush green, present amidst the busy and concrete city Bangalore, Karnataka. The reserve forest is located amidst human habitation, on the all the boundaries of the forest comprises four regions namely; scrub jungle towards north, bamboo, eucalyptus and miscellaneous growth in the north east, *Acacia agriculiformis* jungle in the south east and Jalari natural forest towards the west.

Fig 1: A satellite image of JP Nagar Reserve Forest

The butterfly survey was undertaken from April 2018 November 2018. During pre-monsoon season (April to May), monsoon (June to August) and post monsoon (September to November) at random intervals. Butterflies were sampled by direct visual observation and line - transect method [14, 15, 16, 11]. during morning from 8:30h to 11:00h when the butterflies were most active, with the aid of a binocular. Photographic documentation was done with a camera (Sony DSC-HX10V). The butterflies were categorized as Very rare (VR), Occasional (O), Common (C) and Very common (VC) based on the sightings. The species richness, diversity and evenness indexes were calculated based on Simpson (1949) and Shannon and Weiner (1949).

1. Shannon-Weiner index

$$H = \sum_{i=1}^{\delta} Pi \ln Pi$$

2. Shannon Evenness index

$$E = \frac{Hmax}{\ln(S)}$$

3. Simpsons diversity index

$$D = \sum (n/N)^2$$

3. Results and Discussion

Analysis of the data, revealed that the Doresanipalya Reserve forest was rich in the diversity of the butterflies. A total of 68 species of butterfly were recorded under six families, sixteen subfamilies and forty-seven genera Papilionoidea, Pieridae, Nymphalidae, Riodinidae, Lycanidae and Hesperiidea. A complete list of the butterflies that was recorded during the study is provided in the table 1. It is evident that the most dominant family was Nymphalidae with 24 species (35%) followed by Lycaenidae with 17 species (25%), Hesperiidae with 10 species (15%), Papilionoidea with 8 species (12%), Pieridae with 8 species (12%) and Riodinidae with 1 species (1%).

Table 1: Species abundance in Doresanipalya reserve forest

SL NO	Common name	Scientific name	Remarks	Occurancestatus	Pre-monsoon	Monsoon	Post-monsoon
Hesperiidea							
1	Southern Chestnut Bob	*Iambrix salsala luteipalpis*	Basking	R	-	+	+
2	Grass Demon	*Udaspes folus*	Nectaring	R	-	-	+
3	Common Banded Awl	*Hasora chromus*	Basking	O	-	-	+
4	Common Snow Flat	*Tagiades japetus obscurus*	Basking	O	-	+	+
5	Tricolour Pied Flat	*Coladenia indrani indra*	Basking	VR	-	+	+
6	Bispot Banded Ace	*Halpe porus*	Basking	VR	-	-	+
7	Conjoined Swift	*Pelopidas conjuncta*	Basking	VR	-	-	+
8	Small Branded Swift	*Pelopidas mathias*	Basking	VR	-	-	+
9	Smaller Dartlet	*Oriens goloides*	Basking	VR	-	-	+
10	Karwar Swift	*Caltoris canaraica*	Seen on leaf	R	-	-	+
Papilionoidea							

11	Common Mormon	*Papilio polytes*	Flying, Nectaring	VC	+	+	+
12	Blue Mormon	*Papilio polymnestor*	Flying	R	+	+	+
13	Crimson Rose	*Pachliopta hector*	Flying, Nectaring	C	+	+	+
14	Common Rose	*Pachliopta aristolochiae*	Mating, Flying, Nectaring	C	+	+	+
15	Tailed jay	*Graphium agamemnon*	Flying	C	+	+	+
16	Common Jay	*Graphium doson*	Flying	C	+	+	+
17	Lime Swallowtail	*Papilio demoleus*	Resting, Mud-puddling, Flying	C	+	+	+
18	Narrow-banded Bluebottle	*Graphium teredon*	Flying	C	-	+	+
			Pieridae				
19	Indian Wanderer	*Pareronia hippia*	Flying	C	+	+	-
20	Common Grass Yellow	*Eurema hecabe*	Mud-puddling	VC	+	+	+
21	Lemon Emigrant	*Catopsilia pomona*	Flying	VC	+	+	+
22	Mottled Emigrant	*Catopsilia pyranthe*	Flying	C	+	+	+
23	Spotless Grass Yellow	*Eurema laeta*	Nectaring	VC	+	-	+
24	Three-spot Grass Yellow	*Eurema blanda*	Nectaring	VC	-	-	+
25	Small Grass Yellow	*Eurema brigitta*	Nectaring	VC	-	+	+
26	White Orange-tip	*Ixias marianne*	Flying, Resting	R	-	+	+
			Nymphalidae				
27	Dark Blue Tiger	*Tirumala septentrionis*	Congregation was seen, Flying, Mud-puddling, Neturing	VC	+	+	+
28	Plain Tiger	*Danaus chrysippus*	Basking, Flying, Mud-puddling	VC	+	+	+
29	Striped Tiger	*Danaus genutia*	Basking, Flying, Mud-puddling	VC	+	+	+
30	Double Branded Crow	*Euploea sylvester*	Congregation was seen, Flying, Mud-puddling, nectaring	VC	+	+	+
31	Common Crow	*Euploea core*	Mud-puddling, flying	VC	+	+	+
32	Baronet	*Euthalia nais*	Basking	C	+	+	+
33	Chocolate Pansy	*Junonia iphita*	Mud-puddling, basking, flying	VC	+	+	+
34	Yellow Pansy	*Junonia hierta*	Basking	R	-	+	+
35	Lemon Pansy	*Junonia lemonias*	Basking, mud-puddling	VC	+	+	+
36	Chestnut Streaked Sailer	*Neptis jumbah*	Flying, basking	C	+	+	+
37	Common Sailer	*Neptis hylas*	Flying, basking	C	+	+	+
38	Great Eggfly	*Hypolimnas bolina*	Flying	R	+	-	-
39	Danaid Eggfly	*Hypolimnas misippus*	Flying	R	+	-	+
40	Commander	*Moduza procris*	Flying	VR	+	-	-
41	Common Leopard	*Phalanta phalantha*	Basking	R	+	-	-
42	Bamboo Treebrown	*Lethe europa*	Mud-puddling, basking	O	-	+	+
43	Tawny Coster	*Acraea terpsicore*	Flying	R	+	-	+
44	Common castor	*Ariadne merione*	Flying, basking	C	+	+	+
45	Angled castor	*Ariadne Ariadneindica*	Flying, basking	C	-	+	+
46	Common Four-ring	*Ypthima huebneri*	Nectaring	VC	-	+	+
47	Common Three-Ring	*Ypthima Asterope mahratta*	Nectaring	VC	-	+	+
48	Tailed Palmfly	*Elymnias caudate*	Basking	R	-	+	+
49	Dark Branded Bushbrown	*Mycalesis mineus*	Mud-puddling	C	-	+	+
50	Common Bushbrown	*Mycalesis perseus*	Mud-puddling	C	-	+	+
			Riodinidae				
51	Double-banded Judy	*Abisara bifasciata*	Basking	R	-	+	+
			Lycaenidae				
52	Pea blue/Long tailed blue	*Lampides boeticus*	Nectaring	R	+	-	-
53	Zebra Blue	*Leptotes plinius*	Seen on leaf	R	+	-	+
54	Tailless Lineblue	*Prosotas dubiosa*	Mud-puddling	R	+	+	+
55	Lankan Large Oakblue	*Arhopala amantes*	Seen on leaf	R	+	+	+
56	Indian Sunbeam	*Curetis thetis*	Flying	R	+	-	+
57	Common Pierrot	*Castalius rosimon*	Nectaring	C	+	+	+
58	Common Guava Blue	*Virachola isocrates*	Nectaring	VR	+	-	-
59	Small Cupid	*Chilades parrhasius*	Nectaring	C	+	+	+
60	Plains Cupid	*Chilades pandava*	Nectaring	C	+	+	+
61	Tiny Grass Blue	*Zizula hylax*	Mud-puddling	C	+	+	-
62	Lime Blue	*Chilades lajus*	Basking	C	+	+	+
63	Forget-me-not	*Catochrysops strabo*	Was seen on leaf	VR	+	-	-
64	Common Cerulean	*Jamides celeno*	Seen on leaf	VR	+	-	+

65	Common Gull	*Cepora nerissa phryne*	Nectaring	VR	-	-	+
66	Malabar Common Hedge Blue	*Acytolepis puspa felderi*	Mud-puddling	R	-	-	+
67	Dakhan Silverstreak Blue	*Iraota timoleon arsaces*	Mud-puddling, Flying	R	-	-	+
68	Dull Babul Blue	*Azanus jesous*	Mud-puddling	R	-	-	+

Occurrence status: VR (Very rare - 10), R (Rare - 20), O (Occasional - 3), C (Common - 20) and VC (Very common - 15)

From the data obtained, it was found that *Euploea sylvester* (Double branded crow), *Tirumala septentrionis* (Dark blue tiger), *Junoniaiphita* (Chocolate pansy), *Junonia lemonias* (Lemon pansy), *Catopsilia pomona (*Lemon Emigrant) were the common butterflies which could be seen in large numbers in the JP Nagar Reserve forest. *Jamides celeno* (Common Cerulean), *Papilio polymnestor* (Blue mormon), *Catochrysops strabo* (Forget me Not), *Chilades lajus* (Lime Blue) etc., were among the rare species that were seen.

Table 2: Family wise depiction of butterfly species

Sl.no	Family	No. of species	Occurence
1	Hesperiidea	10	15
2	Papilionoidea	8	12
3	Pieridae	8	12
4	Nymphalidae	24	35
5	Riodinidae	1	1
6	Lycaenidae	17	25

The study was conducted to analyze the seasonal variations in the diversity of butterflies, i.e. pre-monsoon, monsoon and post-monsoon variations. The Shannon Weiner index for the study period was found to be maximum during the post-monsoon season and minimum during the pre-monsoon season, evenness index was found to be maximum during pre-monsoon and minimum during the monsoon season and the Simpsons diversity index was found to be maximum during the post-monsoon and minimum during the pre-monsoon season.

Table 3: Table showing the various indices

Sl.no	Index	Pre-monsoon	Monsoon	Post-monsoon
1	Shannon Weiner index	1.27	1.43	1.51
2	Evenness index	0.92	0.79	0.84
3	Simpsons diversity index	0.73	0.75	0.79

From the seasonal study that was performed depicted in the fig 2, it was found that the number of butterflies in the post monsoon were more, with a total of 60 species out of the total, in the monsoon season a total of 44 species were found and during the pre-monsoon season a total of 41 species were found.

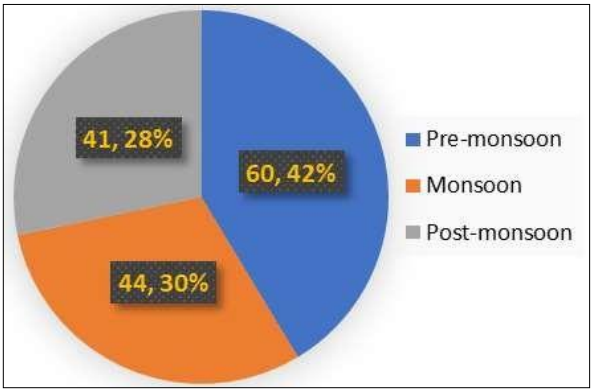

Fig 2: Graph depicting the seasonal distribution of the butterflies

During the study it showed that the number of *Euploea sylvester* (Double Branded Crow) were found to be in large number during the initial days of the study i.e. during the period of April to June 2018 as these were the migrating butterflies. They were seen in large numbers in the nursery area of the Doresanipalya Reserve forest. The number of the *Euploea sylvester* started to decrease as the monsoon season approached nearby. The number of *Eurema hecabe* (Common Grass Yellow), *Eurema brigitta* (Small Grass yellow) and *Eurema blanda* (Three-spot grass yellow) increased during the monsoon season. This might be due to the availability of the host plant in large numbers. Some butterflies like the Common Gull and Malabar Common Hedge blue were seen only after late monsoon, butterflies like Common Mormon, Crimson Rose, Common Rose, Tailed Jay, Common Jay, Lime Swallowtail, Dark Blue Tiger, Plain Tiger, Striped Tiger, Chocolate Pansy, Lemon Pansy, Common Castor, Common Pierrot and Plains Cupid were seen throughout the year. This could be, because they are not season dependent, they can adapt to the variations in the temperature and are stress tolerant.

This observation is quite significant and it emphasizes the importance of conservation of species in the Doresanipalya Reserve Forest

1

2

3

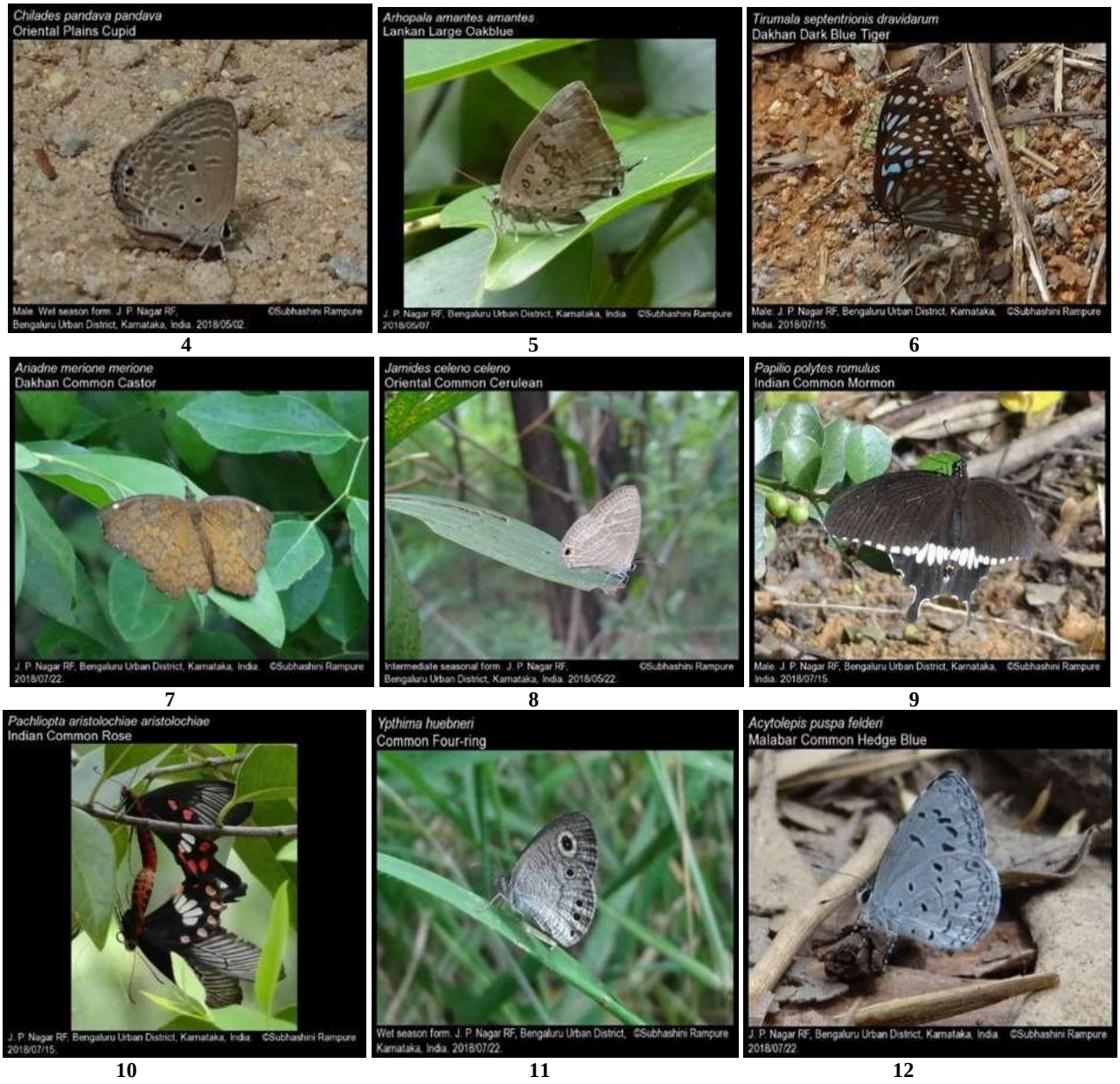

Fig 1-12: Butterfly diversity in Bangalore urban

5. Conclusion

The study on the diversity of butterflies has given us an immense knowledge about the various species of butterflies that are present in the reserve forest. We found a total of 68 species of butterfly belonging to 2 major superfamilies, Hesperioidea and Papilionoidea and 6 families Papilionoidea, Pieridae, Nymphalidae, Riodinidae, Lycanidae and Hesperiidea and 16 subfamilies and 47 genera. We could also find congregation of Dark blue tiger (*Tirumala septentrionis*) and Double branded crow (*Euploea sylvester)* during the pre-monsoon season.

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