

Butterfly Species Diversity, Habitats and Seasonal Distribution in and Around Nagpur City, Central India

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Abstract: Total 145 species of butterflies were recorded at the eight study sites, of which 62 species were new records for the Nagpur city. The highest number of butterflies was recorded belonging to the Nymphalidae (51 species) with 17 new records, followed by Lycaenidae (46 species) with 29 new records, Hesperidae (22 species) with 14 new records, Pieridae (17 species) with 4 new records and Papilionidae (9 species). This study revealed that Nymphalidae was most dominating family with a highest number of species in 6 out of 8 sites. The highest number of butterfly species (104) was recorded at site-5 (Ambazari garden and bare land at Lake Side) followed by 98 at site-1 (Seminary hills), 95 at site-2 (Satpuda botanical garden), 90 at site-6 (sides of National Highway), 84 at site- 3 (Bull rearing center), 72 species at site-8 (Futala farm), 69 species at site- 4 (RTM Nagpur University and LIT Campuses) and 50 species at site-7 (Maharaja Bag). Most butterfly species were observed from the monsoon (hot/wet season) to early winter (cool/wet season) but thereafter declined in early summer (March). Among the 145 butterflies recorded, 24 species come under the protection category as per the Indian Wild Life protection Act 1972.

Key words: India • Lepidoptera • Nagpur City (Central India) • Habitat • Seasonal Distribution • Diversity

INTRODUCTION

Insects comprise more than half of earth's diversity of species [1]. Healthy biological communities depend on insects as pollinators, seed dispersers, herbivores, predators and prey. Within the ecological communities, insects comprise a large proportion of the biomass and are critical conduits of energy through the system [2].

Butterflies are generally regarded as one of the best taxonomically studied groups of insects [3], yet even in genera containing very common and widespread species, our understanding of true species diversity may prove to be startlingly below common expectation [4, 5]. They have been studied systematically since the early 18th century and about 19,238 species are documented worldwide by 1998 [6]. This figure is not constant because of the continuous addition of new butterflies and also due to ongoing disagreements between taxonomists over the status of many species.

Nagpur city is the second capital of Maharashtra state and located in the center of India at 20° 9' N and 79° 9' E altitude. It has tropical dry equable climate having three main seasons: June/July wet Monsoon and its aftermath from June till October, the cool dry winter from October/November to February /March and the hot dry season from April till the onset of rains. Temperature of city ranges from minimum of 12-25°C to maximum 30-45°C with a relative humidity 10-15% to 60-95%. Annual precipitation is 1138.5 mm. Ninety percent of the precipitation takes place within four months, i.e., from June to September, July being the rainiest month.

This combination is cost to change butterfly diversity in each season. The Nagpur city is known for maintaining greenery throughout, although most of the areas are civilized and developed. There are many recreation resources comprising of 4-5 major gardens, 10-15 small gardens, 2-3 national institutes and University campus with dense vegetations, some large open space areas and

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3-4 large water resources etc. These areas provide wide range of habitats for butterflies in and around Nagpur city. It ranges from wild forest Seminary Hill to Futala farm grassland; Satpuda botanical gardens to lake banks and bare lands; high way side ornamental plants to Agricultural lands. The size of city has been expanded enormously during the last 15 years maintaining the total green areas which provide food and shelter in the form of nectar and larval host plants to the butterflies and are the best sites for butterfly studies. Parks and natural areas are isolated from one another by busy road, rail lines and water stream providing different habitats for butterflies.

India hosts about 1,501 species of butterflies [7] of which peninsular India hosts 350 and the western Ghat 333. In central India the butterfly species diversity was reported earlier by D'Abreeu (1931) and documented total 177 species occurring in the erstwhile Central Provinces (now Madhya Pradesh and Vidarbha). In addition to this he provided a special list of 92 species butterflies from Nagpur city. Later on Pandharipande (1990) recorded only 61 species of butterflies from the Nagpur city.

The present study was started with a view to examine the diversity and dynamics of butterfly population across seasons and habitats. The present analysis is intended to reveal the seasonal patterns in butterfly populations, status, occurrence, biotope (Habitats of occurrence) and seasonal distribution. Despite its limitations, this study did attempt, perhaps for the first time, butterfly monitoring in Central India with wide objectives of study.

MATERIALS AND METHODS

The findings presented here are based on a field survey and investigations carried out by ADT on a daily basis from June 2006 to May 2008 at 8 sites in and around area of Nagpur city. Observations were made during a fixed daily three transects each of 500 m length with 5 m on either side covered in an hour walking at a constant pace. All the butterflies on the line as well as 5 m on either side were recorded with time and number of individuals seen between 7:00 h and 11:00 h when butterflies were basking. Flight periods, seasonality and abundance of butterfly species in different habitats were also recorded. Butterfly species were identified directly in the field or, in difficult cases, following capture or photography. Collection was restricted to those specimens that could not be identified directly. All scientific names follow Varshney (1983), Kunte (2000) and common English names are after Wynter-Blyth (1957).

Identification of Butterfly Species: Identification of the butterflies was primarily made directly in the field. In critical condition, specimens were collected only with handheld aerial sweep nets. Each specimen was placed in plastic bottles and carried them to the laboratory for further identification with the help field guide [8, 9, 10] and Butterfly Taxonomist. The observed butterflies were grouped in five categories on the basis of number of sighting in the field. The butterflies were categorized as Very Common (VC), Common (C), Not Rare (NR), Rare (R) and Very Rare (VR) [11, 12].

Study Sites: All the study sites were within and around Nagpur city within a radius of 20 km. In all, 8 sites and 20 transects of 500 m each were chosen on the basis of their contrasting vegetation types and levels of disturbance. The sites were as follows

Site-1 Seminary Hills (S1-s3): It is located towards north-west side of Nagpur. Natural vegetation was a forest type with *Tectona grandis* (Teak) as a dominant tree species and *Lantana camera* as dominant weed. It is spread over 67 ha. Three transect sites designated with S1, S2 and S3 codes. Lopping, Carvia collection and cattle grazing were present on small scale.

Site-2 Satpuda Botanical Garden (B1-b3): It is located at west side of Nagpur spreading over 25 ha. Hill and Lake County (Futala) had a mixed vegetation comprising ornamental, fruit plants, scrub, grassland; some part with natural forest dominated with weed *Lantana camera*. Three transect sites designated with B1, B2 and B3 codes.

Site-3 Agricultural Land, Bull Rearing Center (L1-l3): The geographical position of this site is at west side of Nagpur city. The vegetation was of mixed type with cultivated fodder plants (e.g., Barseam and Jawar) and wild forest plantation, scrub and grassland for grazing. Entire area measured about 44 ha. Codes used to designate this site were L1, L2 and L3.

Site-4 Rtm Nagpur University and Laxminarayan Institute of Technology (Lit) Campuses (U1-u3): The site is located within west site of Nagpur city. Vegetation type was mixed with ornamental plants near buildings, natural plantations in some areas and the rest of the area with scrub and extensive grasslands (89 ha). The codes for transects were U1, U2 and U3. The area is disturbed by concrete structures.

Site-5 Ambazari Garden and Bare Land at Lake Side (A1-a3): Containing ornamental, flowering plants, forest, scrub and grassland (6 ha), above site spread over 6 ha and is situated on west side of Nagpur city. It showed wide habitat range. This site had varying forms of ornamental flowering gardens, wild forest, scrubs, grassland and big water body. The site was much disturbed due to human interference. The transect codes were named as A1, A2 and A3.

Site-6 Sides of National Highway (R1-r3): On south side of Nagpur, along the sides of National Highway ornamental vegetation was one of the sites for the study. The site extends up to 2 km. The site was rich in ornamental and wild plants providing sites for butterfly nectaring and egg-laying. Heavy traffic on the high way disturbed the site at the most. Transects were named as R1, R2 and R3.

Site-7 Maharaj Bag (M1): This site spreads over 3.5 ha and is located in the center of Nagpur city. It showed wide habitat range varying form ornamental flowering gardens to wild forest, scrubs, grassland and big water body. The site was much disturbed due to human interference. Because of smaller area only one transect was used for study and named as M1.

Site-8 Futala Farm Area (F1): The position of this site is at west side of Nagpur city spread over 10 ha. The vegetation was of mixed type with forest vegetation, ornamental plat area and grassland .The site was much impacted with animal interference for grazing. The transect under study was named as F1.

RESULTS

During the course of study 145 species of butterflies, belonging to 5 families, were recorded of which 62 species were new records in and around Nagpur city. Most butterflies recorded belong to the Nymphalidae (51 species) with 17 new records from Nagpur city (i.e. *Melanitis phedima*, *Lethe rohria*, *Mycalesis subdita*, *Mycalesis igilia*, *Mycalesis visala*, *Mycalesis francisca*, *Mycalesis malsara*, *Ypthima inica*, *Ypthima baldus*, *Polyura agrarian*, *Charaxes marmax*, *Phalanta alcippe*, *Neptis jumbah*, *Athyma perius*, *Tirumala septentrionis*, *Parantica aglea*, *Euploea klugii*). 46 Lycaenidae species were recorded with 29 new records (i.e. *Tarucus ananda*, *Tarucus nara*, *Azanus*

ubaldus, *Azanus uranus*, *Everes lacturnus*, *Actolepis puspa*, *Celatoxia albidisca*, *Celestrina lewendularis*, *Udara singalensis*, *Anthene emolus*, *Anthene lycaenina*, *Psuedozizeeria maha*, *Zizeeria karsandra*, *Chilades laius*, *Chilades parrhasius*, *Freyeria pulti*, *Jamides alecto*, *Nacaduba kurava*, *Nacaduba beroe*, *Prosotas nora*, *Prosotas dubiosa*, *Petrolaea dana*, *Ionolyce helicon*, *Spindasis schistacea*, *Spindasis ictis*, *Spindasis elima*, *Virachola isocrates*, *Arhopala amantes*, *Amblypodia anita*). A total of 22 Hesperidae species were recorded with 14 new records (i.e., *Hasora taminatus*, *Psuedocoladenia dan*, *Odontoptilum ransonnetti*, *Udaspes folus*, *Suastus gremius*, *Taractrocera maevius*, *Taractrocera ceramas*, *Pelopidas mathias*, *Oriens goloides*, *Pelopidas conjuncta*, *Polytremis lubricans*, *Pelopidas subochracea*, *Baoris farri*, *Caltoris canaraica*). In Pieridae 17 species with 4 new records were recorded (i.e. *Eurema andersonii*, *Appias libythea*, *Appias albina*, *Ixias pyrene*) and 9 species were recorded from the Papilionidae. Comparatively Nymphalidae was most dominating family having highest number of species at 6 out of 8 sites (Fig. 1, Table 2).

Among the 145 species of butterflies about 28 % (41) were occurring very common, 27% (39) species were common, 6% (09) were not rare, 26% (38) were rare and 13% (18) were very rare (i.e. *Graphium sarpedon*, *Papilio polymnestor*, *Appias albino*, *Ixias pyrene*, *Lethe rohria*, *Orsotrianea medus*, *Charaxes marmax*, *Phalanta alcippe*, *Parantica aglea*, *Abisara echerius*, *Talica nyseus*, *Azanus ubaldus*, *Udara singalensis*, *Ionolyce helicon*, *Arhopala amantes*, *Amblypodia anita*, *Hasora taminatus*, *Polytremis lubricans*). The observed and identified species, their status in and around of Nagpur city at different sites are listed in Table 1.

Seasonal patterns of species richness (flight periods) for the eight sites in and around the Nagpur city, are presented in Fig. 2. Most butterfly species were observed from the monsoon (hot/wet season) to early winter (cool/wet season) but thereafter declined in early summer (March).

Among the 145 butterflies recorded, 24 species come under the protection category of the Indian Wild Life (protection) Act 1972 [10]. Among them *Neptis jumbah*, *Actolepis puspa*, *Amblypodia anita*, *Pachliopta hector*, *Lethe europa*, *Neptis columella*, *Castalius rosimon*, *Hypolimnas misippus* came under schedule I of the act. The species recorded which come under schedule II of the wild life protection act 1972 were *Hypolimnas misippus*, *Eurema andersonii*, *Appias albina*, *Mycalesis malsara*,

Table 1: Butterfly species of in and around Nagpur city (Central India) together with common name, occurrence and status.

Common Name	Scientific Name	Occurrence (months)	Status	Biotope
Papilionidae(9)				
Common Rose	<i>Pachliopta aristolochiae</i>	7-3	C	S,B,L,U,A,R, M, F
Crimson Rose	<i>Pachliopta hector</i>	7-4	C	S,B,L,U,A,R, M, F
Common Bluebottle	<i>Graphium sarpedon</i>	10	VR	L
Common Jay	<i>Graphium doson</i>	8-3	VC	S,B,L,U,A,R, M, F
Tailed Jay	<i>Graphium agamemnon</i>	8-3	C	S,B,L,U,A,R, M, F
Spot Swordtail	<i>Graphium nomius</i>	3-7	R	B, U, A
Lime	<i>Papilio demoleus</i>	1-12	VC	S,B,L,U,A,R, M, F
Common Mormon	<i>Papilio polytes</i>	7-2	C	S,B,L,U,A,R, M, F
Blue Mormon	<i>Papilio polymnestor</i>	9	VR	R, M
Pieridae (17)				
Lemon Emigrant	<i>Catopsilia pomona</i>	1-12	VC	S,B,L,U,A,R, M, F
Mottled Emigrant	<i>Catopsilia pyranthe</i>	1-12	VC	S,B,L,U,A,R, M, F
Small Grass Yellow	<i>Eurema brigitta</i>	1-12	VC	S,B,L,U,A,R, M, F
Spotless Grass Yellow	<i>Eurema laeta</i>	6-12	C	S,B,L,U,A,R, M, F
One-Spot Grass Yellow	<i>Eurema andersonii</i> [#]	8-2	NR	S,B,A,F
Common Grass Yellow	<i>Eurema hecabe</i>	1-12	VC	S,B,L,U,A,R, M, F
Three-Spot Grass Yellow	<i>Eurema blanda</i>	7-3	C	S,B,L,U,A,R, M, F
Common Jezebel	<i>Delias eucharis</i>	7-3	C	S,B,L,U,A,R, M, F
Common Gull	<i>Cepora nerissa</i> [*]	1-12	VC	S,B,L,U,A,R, M, F
Pioneer Or Caper White	<i>Anaphaeis aurota</i>	9-3	C	S,B,L,U,A,R, M, F
Eastern Striped Albatross	<i>Appias libythea</i> ^{**}	1-3	NR	B,L,F
Common Albatross	<i>Appias albina</i> ^{**}	12-2	VR	S
Small Orange Tip	<i>Colotis etrida</i>	7-12	R	S,U
Yellow Orange Tip	<i>Ixias pyrene</i> [#]	8-10	VR	R
Crimson Tip	<i>Colotis danae</i>	6-10	C	S,B,A,R
White Orange Tip	<i>Ixias marianne</i>	8-11	R	A,R
Common Wanderer	<i>Pareronia valeria</i> [*]	8-3	VC	S,B,L,U,A,R, M, F
Nymphalidae (51)				
Common Evening Brown	<i>Melanitis leda</i>	1-12	VC	S,B,L,U,A,R, M, F
Great Evening Brown	<i>Melanitis zitenius</i> [*]	8-1	R	S
Dark Evening Brown	<i>Melanitis phedima</i> [#]	8-12	C	S,B
Bamboo Treebrown	<i>Lethe europa</i> [*]	8-3	C	S,B,A,R
Common Treebrown	<i>Lethe rohria</i> [#]	8-9	VR	B
Common Bushbrown	<i>Mycalasis perseus</i>	7-3	VC	S,B,L,U,A,R, M, F
Dark Branded Bushbrown	<i>Mycalasis mineus</i>	8-3	C	S,B,L,A,R,F
Tamil Bushbrown	<i>Mycalasis subdita</i> [#]	8-12	NR	S,B,U,A,R
Small Longbrand Bushbrown	<i>Mycalasis igilia</i> [#]	8-10	R	S
Longbrand Bushbrown	<i>Mycalasis visala</i> [#]	8-9	R	B,L
Lilacine Bushbrown	<i>Mycalasis francisca</i> [#]	9-10	R	S,B,L
Whiteline Bushbrown	<i>Mycalasis malsara</i> ^{**}	10	R	S,B
Nigger	<i>Orsotrianea medus</i>	8-9	VR	S
Common Threering	<i>Ypthima asterope</i>	7-9	R	R, F
Common Four Ring	<i>Ypthima huebneri</i>	11-12	R	L
Lesser Threering	<i>Ypthima inica</i> [#]	7-3	C	S,B,L,A,R
Common Fivering	<i>Ypthima baldus</i> [#]	9	R	S,A
Common Nawab	<i>Polyura athamas</i>	12-2	R	B,R
Anomalous Nawab	<i>Polyura agraria</i>	2-3	R	A
Yellow Rajah	<i>Charaxes marmax</i> ^{**}	1-2	VR	L,U
Tawny Rajah	<i>Charaxes polyxena</i>	11	R	L,A
Black Rajah	<i>Charaxes solon</i>	10-2	R	S,B
Tawny Coster	<i>Acraea violae</i>	1-12	VC	S,B,L,U,A,R, M, F
Common Leopard	<i>Phalanta phalantha</i>	6-3	VC	S,B,L,U,A,R, M, F
Small Leopard	<i>Phalanta alcippe</i> [#]	8-9	VR	L
Short Banded Sailer	<i>Neptis columella</i> [*]	10-11	R	S,A
Chestnut-Streaked Sailer	<i>Neptis jumbah</i> ^{**}	11	R	A
Common Sailer	<i>Neptis hylas</i>	6-4	VC	S,B,L,U,A,R, M, F
Common Sergeant	<i>Athyma perius</i> [#]	8-11	NR	S,A,R
Commander	<i>Limenitis procris</i>	8-1	C	B,L,A,R
Common Baron	<i>Euthalia aconthea</i>	8-11	R	S,A,R,F
Baronet	<i>Euthalia nais</i>	10-3	C	S,B,L,A,R,F
Joker	<i>Byblia lithyia</i>	1-12	C	S,B,L,U,A,R
Angled Castor	<i>Ariadne ariadne</i>	9-2	VC	S,B,L,U,A,R,F
Common Castor	<i>Ariadne merione</i>	10-2	C	S,B,L,U,A,R

Table 1: Continued

Yellow Pansy	<i>Junonia hierta</i>	7-2	C	S,B,L,U,A,R, M, F
Blue Pansy	<i>Junonia orithya</i>	10-4	VC	S,B,L,U,A,R, M, F
Lemon Pansy	<i>Junonia lemonias</i>	1-12	VC	S,B,L,U,A,R, M, F
Peacock Pansy	<i>Junonia almana</i>	1-12	VC	S,B,L,U,A,R, M, F
Grey Pansy	<i>Junonia atlites</i>	8-3	VC	S,B,L,U,A,R, M, F
Chocolate Pansy	<i>Junonia iphita</i>	8-3	C	S,B,L,U,A,R, M, F
Painted Lady	<i>Cynthia cardui</i>	5-7	C	S,B,A,R
Great Eggfly	<i>Hypolimnas bolina</i>	1-12	C	S,B,L,U,A,R, M, F
Danaid Eggfly	<i>Hypolimnas misippus*</i>	1-12	VC	S,B,L,U,A,R, M, F
Blue Tiger	<i>Tirumala limniace</i>	1-12	VC	S,B,L,U,A,R, M, F
Dark Blue Tiger	<i>Tirumala septentrionis#</i>	8-12	R	S,B,F
Glassy Tiger	<i>Parantica aglea#</i>	6-7	VR	B
Plain Tiger	<i>Danaus chrysippus</i>	1-12	VC	S,B,L,U,A,R, M, F
Striped Tiger	<i>Danaus genutia</i>	10-6	VC	S,B,L,U,A,R, M, F
Common Indian Crow	<i>Euploea core*</i>	1-12	VC	S,B,L,U,A,R, M, F
Brown King Crow	<i>Euploea klugii#</i>	8-3	NR	B,L,R
Lycaenidae (45)				
Plum Judy	<i>Abisara echerius</i>	8	VR	A
Common Pierrot	<i>Castalius rosimon*</i>	1-12	VC	S,B,L,U,A,R, M, F
Dark Pierrot	<i>Tarucus ananda**</i>	6-9	R	A,F,M
Rounded Pierrot	<i>Tarucus nara#</i>	1-12	VC	S,B,L,U,A,R, M, F
Red Pierrot	<i>Talicauda nyseus</i>	7	VR	A
Zebra Blue	<i>Leptotes plinius</i>	1-12	VC	S,B,L,U,A,R, M, F
Bright Babul Blue	<i>Azonus ubaldus#</i>	1-3	VR	B
African Babul Blue	<i>Azonus jesus</i>	10-3	NR	L,A,R,F
Dull Babul Blue	<i>Azonus uranus#</i>		R	S,B
Indian Cupid	<i>Everes lacturnus#</i>	1-2	R	L,U,F
Common Hedge Blue	<i>Actolepis puspa**</i>	9-2	C	S,L,U,A,R
Whitedisc Hedge Blue	<i>Celatoxia albidisca#</i>	8-9	R	B,F
Plain Hedge Blue	<i>Celestrina lewendularis#</i>	10-11	R	B,L,A
Large Hedge Blue	<i>Udara singalensis#</i>	11	VR	L
Ciliate Blue	<i>Anthene emolus#</i>	10-12	R	S,A
Pointed Ciliate Blue	<i>Anthene lycaenina#</i>	8-10	R	B,A
Pale Grass Blue	<i>Psuedozeeria maha#</i>	1-12	C	S,B,L,U,A,R,F
Dark Grass Blue	<i>Zizeeria karsandra#</i>	1-12	VC	S,B,L,U,A,R,F
Lesser Grass Blue	<i>Zizina otis</i>	1-12	VC	S,B,L,U,A,R, M, F
Tiny Grass Blue	<i>Zizula hylax</i>	1-12	VC	S,B,L,U,A,R, M, F
Lime Blue	<i>Chilades laius#</i>	8-12	C	B,U,A,R
Small Cupid	<i>Chilades parrhasius#</i>	6-3	C	B,L,U,A,R
Plains Cupid	<i>Chilades pandava</i>	1-12	VC	S,B,L,U,A,R,F
Grass Jewel	<i>Chilades trochylus</i>	1-12	VC	S,B,L,U,A,R, M, F
Eastern grass Jewel	<i>Chilades pulti#</i>	7-12	C	S,B,L,U,A,R, M, F
Gram Blue	<i>Euchrysops cnejus*</i>	6-4	VC	S,B,L,U,A,R, M, F
Forget-Me-Not	<i>Catochrysops strabo</i>	1-12	VC	S,B,L,U,A,R, M, F
Pea Blue	<i>Lampides boeticus*</i>	8-4	VC	S,B,L,U,A,R,F
Dark Cerulean	<i>Jamides bochus</i>	7-3	C	L,U,A,R
Common Cerulean	<i>Jamides celeno*</i>	7-3	VC	S,B,L,U,A,R, M, F
Metallic Cerulean	<i>Jamides alecto**</i>	8-10	R	S,B,L,U,A,R, M, F
Transparent 6-Line Blue	<i>Nacaduba kurava#</i>	8-12	C	B,L,U,A
Opaque 6-Line Blue	<i>Nacaduba beroe#</i>	8-10	C	S,R
Common Line Blue	<i>Prosotas nora</i>	7-4	VC	S,B,L,U,A,R, M, F
Tailless Line Blue	<i>Prosotas dubiosa#</i>	7-9	C	S,B,L,A
Dingy Line Blue	<i>Petrolaea dana#</i>	8-9	R	B,A
Pointed Line Blue	<i>Ionolyce helicon#</i>	9-10	VR	A
Common Silverline	<i>Spindasis vulcanus</i>	8-2	NR	S,B,L,U,A,R
Plumbeous Silverline	<i>Spindasis schistacea#</i>	7-8	R	R
Shot Silverline	<i>Spindasis ictis#</i>	6-7	R	B
Scarce Shot Silverline	<i>Spindasis elima**</i>	5-6	R	B,F
Indian Red Flash	<i>Rapala iarbus</i>	11-4	C	R,L,U,F
Common Guava Blue	<i>Virachola isocrates#</i>	8-10	NR	B,U,A
Large Oakblue	<i>Arhopala amantes#</i>	5	VR	A,F
Slate Flash	<i>Rapala manea</i>	7-10	C	S,L,A
Leaf Blue	<i>Amblypodia anita**</i>	8-9	VR	A,F

Table 1: Continued

Hesperiidae (22)				
Common Banded Awl	<i>Hasora chromus</i>	7-12	C	S,B,A,R
White Banded Awl	<i>Hasora taminatus</i> [#]	8-10	VR	A,R,F
Fulvous Pied Flat	<i>Psuedocoladenia dan</i> [#]	9	R	S
Golden Angle	<i>Odontoptilum ransonnetti</i> [#]	10-11	R	S,B
Indian Skipper	<i>Spialia galba</i>	8-3	C	S,B,L,R
Grass Demon	<i>Udaspes folus</i> [#]	9-12	C	B,L,U,A,R
Indian Palm Bob	<i>Suastus gremius</i> [#]	7-12	C	S,B,A,R
Common Grass Dart	<i>Taractrocera maevius</i> [#]	8-10	R	S,B,A
Tamil Grass Dart	<i>Taractrocera ceramas</i> [#]	9-10	R	S,A
Dark Palm Dart	<i>Telicota ancilla</i>	8-12	VC	S,B,L,U,A,R,F
Pale Palm Dart	<i>Telicota colon</i>	7-9	C	S,U,A,F
Small-Branded Swift	<i>Pelopidas mathias</i> [#]	7-12	VC	S,B,L,U,A,R, M, F
Indian/Common Dartlet	<i>Oriens goloides</i> [#]	9-10	R	A,R
Conjoined Swift	<i>Pelopidas conjuncta</i> [#]	8-12	NR	A,R
Contiguous Swift	<i>Polytremis lubricans</i> [#]	9-10	VR	L
Straight Swift	<i>Parnara naso</i>	9-12	C	S,L,A,R
Rice Swift	<i>Borbo cinnara</i>	1-12	VC	S,B,L,U,A,R, M, F
Large Branded Swift	<i>Pelopidas subochracea</i> [#]	10-11	R	A,R
Bevan's Swift	<i>Borbo bevani</i>	8-11	VC	S,L,A,R
Paintbrush Swift	<i>Baoris farri</i> ^{*#}	10-12	VC	S, B, R
Blank Swift	<i>Caltoris kumara</i>	10-11	C	S, B
Kanara Swift	<i>Caltoris canaraica</i> [#]	9-10	R	A,F

Biotope: S- Site 1: Seminary Hills, B- Site-2: Satpuda botanical Garden, L-Site 3: Agricultural Land (Bull Rearing Center), U- Site 4: RTM Nagpur University Campus and LIT Campus, A- Site-5: Ambazari garden and bare land at Lake Side, R-Site 6: Sides of National Highway, M- Site-5: Maharaj bag, F- Site-5: Futala farm area. Status: VC, Very common (> 150 sightings); C, Common (50-150 sightings); NR, Not rare (25-50 sightings); R, Rare (10-25 sightings); VR, Very rare (<10 sightings). * Come under Indian Wild Life protection Act 1972, #New Report.

Table 2: The variations in number of butterfly species occurred at 8 different sites under study

Site	No. butterfly species					
	Total	Papilionidae	Pieridae	Nymphalidae	Lycaenidae	Hesperiidae
Seminary Hills	98	6	14	38	25	15
Satpuda botanical Garden	95	7	13	36	28	11
Agricultural Land, Bull Rearing Center	84	7	11	32	26	8
RTM Nagpur University Campus and LIT Campuss	69	7	11	22	24	5
Ambazari garden and bare land at Lake Side	105	7	13	34	37	14
Sides of National Highway	90	7	13	32	24	14
Maharaj bag	50	8	10	17	13	2
Futala Farm	72	7	12	21	25	7

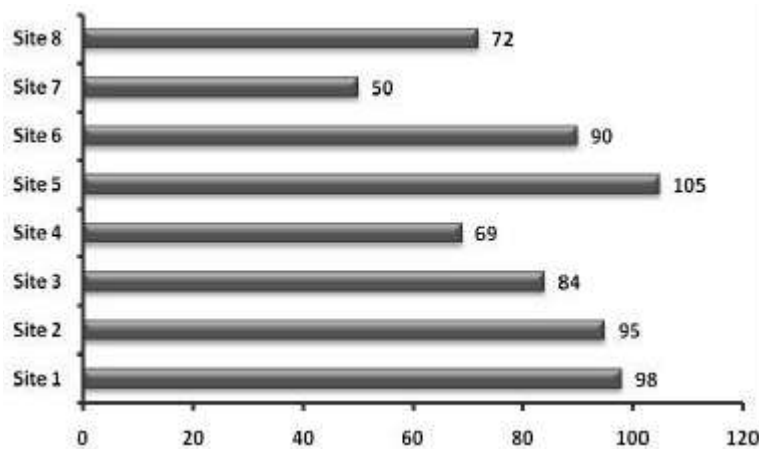


Fig. 1: A comparison of Butterfly species richness across various sites of Nagpur city

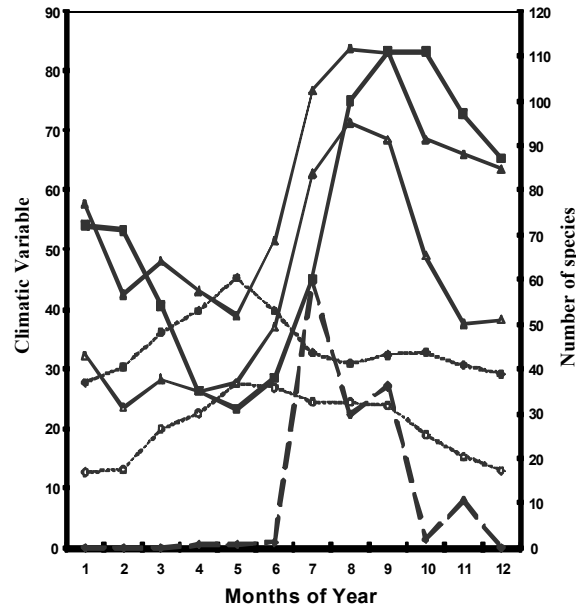


Fig. 2: Seasonal distribution in number of species in and around Nagpur city

Right scale: black squares, number of species. Left scale: climate variables: circles, temperatures (°C); closed circles, maximum mean temperatures (°C); open, minimum mean temperatures (°C); triangles, relative humidity (%); closed triangles, maximum relative humidity (%); open triangles, minimum relative humidity (%); diamonds, rainfall (cm).

Charaxes marmax, *Jamides alecto*, *Spindasis elima*, *Cepora nerissa*, *Pareronia valeria*, *Melanitis zitenius*, *Euchrysops cnejus*, *Lampides boeticus*, *Jamides celeno*. The species recorded which came under schedule IV of the wild life protection act were *Appias libythea*, *Tarucus ananda*, *Baoris farri*, *Euploea core* [13].

DISCUSSION

While surveying for the butterfly species diversity and availability of larval host plants during June 2006 to May 2008 in and around Nagpur city, total 145 butterfly species were recorded with 62 new species previously unrecorded. Earlier D'Abreeu (1931) documented 91 butterfly species; later on Pandharipande (1991) in his preliminary studies recorded 61 species of butterflies in Nagpur City. Present record of total 145 species in Nagpur city indicates that the diversity of butterfly species in Nagpur area has been increased to greater extent. The reason for increase in diversity might be due to the favorable tropical climate conditions, availability of more number of larval host plants and vegetation cover of herbs, shrubs and trees for nectaring of butterflies [14].

Interestingly, butterflies (*Papilio clytia*, *Papilio crino*, *Papilio antiphates*, *Colotis amata*, *Polyommatus baeticus*, *Everes argiades*, *Ypthima avanta*, *Hasora chabrona*, *Badamia exclamationis* and *Taractrocera maevius*) which were recorded earlier from Nagpur were not seen during the present study. The one of the probable main reasons behind this may be the loss of habitats by ever expanding urbanization. During the last decade this city has expanded twice in its circumference causing threats to loss of natural habitats of butterflies. Urban development is expected to have a deleterious impact on butterfly populations, if only because the construction of buildings and concretes replaces or reduces the area of natural and semi-natural habitats. The quality of residual habitats is also expected to be adversely affected by various forms of pollution [15]. Out of 145 reported butterflies, 24 butterfly species came under schedule act showing that the area is rich in butterfly diversity and there is an urgent need to adapt conservation policies. The steps towards their conservations are, development of butterfly park, cultivation and protection of larval and nectar host plants specifically used by these butterflies and provide protection and maintenance of mating sites for the butterflies [11, 16].

Among the 145 species of butterflies, *P. demoleus* (Papilionidae), *C. pomona*, *C. pyranthe*, *E. brigitta*, *E. hecabe*, *C. nerissa* (Pieridae), *M. leda*, *J. lemonias*, *J. almanac*, *H. bolina*, *H. misippus*, *T. limniace*, *D. chrysippus*, *E. core* (Nymphalidae), *C. rosimon*, *T. nara*, *L. plinius*, *P. maha*, *Z. karsandra*, *Z. otis*, *Z. hylax*, *C. pandava*, *F. trochylus*, *C. Strabo* (Lycaenidae) and *B. cinnara* (Hesperiidae) were occurred throughout the year (January-December), whereas remaining 122 species of butterflies were prominently observed only after June till the beginning of summer (April-May). Increasing species abundance from beginning of monsoon (June-July) till the early winter (August-November) and decline in species abundance from late winter (December-January) up to the end of summer have also been reported by Tiple *et al.* (2007) in similar climatic conditions in this region of Central India. They further demonstrated that most of the species were noticeably absent in the disturbed and human impacted sites (gardens, plantation and grassland) and there was no occurrence of unique species in moderately disturbed areas comparable to those of less disturbed wild areas. The present study-site being a Nagpur city is always disturbed and human impacted and once or twice during a year there is a destruction of habitat (cutting of grasses, shrubs and trees) for beautification of city, which may be the reasons for overall reduction of species of uniqueness from disturbed and impacted sites as compared to the other sites of Nagpur city. Kunte (2001) showed that, there was a first peak in late monsoon and second in winter in Pune city which was very much similar to our observations. Padhey *et al.* (2006) noticed differences in observations on seasonal distributions. According to them there are two peaks of species richness, one in summer and the other in early winter which is consistent with that of Wynter-Blyth (1957) and may be due to forest area under study.

Present study revealed that although at undisturbed and wild sites there were less species richness, they were the excellent sites for the occurrence of unique species, whereas in disturbed habitats and human impacted sites species richness was increased but the uniqueness was less. These observations are in good agreement with Padhey *et al.* (2006), Kunte (2001) and Tiple *et al.* (2007) stating that impacted zones are richer in species richness. When comparison was made at different sites under investigation, highest numbers of species were recorded from Ambazari garden and Seminary Hill (104 and 98) while least number of species (50 and 58) from Maharaj Bag garden and RTM Nagpur University and LIT campuses.

The probable reason behind these numerical difference is that Ambazari garden and Seminary Hill provides better opportunity for butterfly species in terms of larval and nectar plants. The Ambazari garden site had a large lake, tree plantation and grass land areas providing various mate location sites for different butterfly species. In contrast to this, Maharaj Bag garden and RTM Nagpur University and LIT campuses having monotonous type of flora of wild plants and was not well protected as many human activities brought about changes in habitats.

The study sites had various habitats ranging from natural forest to agriculture lands and plantation. The butterfly diversity was also varied in these habitats but the pattern of the variation was different. Though bull rearing center site was an agriculture land; it had less number of species than expected. Agriculture and grassland harbour high and lowest species richness, respectively without any species being exclusive to them. Together, wilderness areas i.e. forest, scrub and grasslands harbour three fourth of the species, about one fourth of them being exclusive to wilderness zone. The plantations clogging the township, along with the agriculture represented more human impacted zone which harboured about two third of the total species recorded, but some of them have their larval food plants located in the wilderness zone [17].

Earlier studies on butterfly diversity of some other cities in India indicate that comparatively Nagpur city has richest butterfly diversity (145 species) than cities like Pune (103 species) [18], metropolitan Delhi (86 species) [19], Visakhapatnam (68 species) [20] and Amravati (52 species) [12]. In contrast to this, Tamhini village [21] located in the forest of western ghat exhibited the presence of only 58 butterfly species being a small sized village.

The butterfly fauna of Nilgiri (Blue) Mountains of south India is rich and very interesting with 300 species [22]. Some of the largest Papilionidae such as *Troides minus*, *Papilio helenus daksha*, *P. polymnester* and *P. paris tamilana* are recorded from Nilgiri [22], however, one of these was recorded from Nagpur city i. e. *P. polymnester*. Members of Papilionidae, Lycaenidae and Nymphalidae recorded in Nagpur were also reported in south India [23, 24, 25, 26, 27]. The *Melanitis spp.*, *Mycalesis spp.*, *Ypthima spp.*, *Junonia spp.* and *Chilades spp.* occurred in two different seasonal forms, the wet season form during monsoon (June-October) and it was replaced by camouflaged dry season form which continued throughout the winter and spring (November-May). A seasonal variation in these species was reported earlier by Brakefield and Larsen (1984).

Rich butterfly fauna on the Blue Mountains (South India) might be probably due to favourable climatic conditions such as mild with low temperatures and very high rainfall throughout the year [26] due to direct exposure to southwest monsoon and secondly the thick evergreen forests which differs substantially from the climate of Nagpur (Central India). The climate of Nagpur differs from that of the Blue Mountains with very high temperatures and unusual rainfall. The variations in butterfly fauna between these two regions are attributed to climatic differences of the regions. In the present study seasonal occurrence of butterfly species was high from monsoon (hot/wet season) to early winter (cool/wet season) but thereafter declined in early summer (March). The cause of this decline might be non-availability of nectar and larval host plants, scarcity of water and cutting of grasslands. The importance of resource types (consumer and utilities) is indicated in a number of studies in temperate contexts [29], for example, the recorded shifts in nectar flower use with emergence period and broods [31]. At the eight sites, we observed that the build-up in the numbers of species and populations took place from the early monsoon and exhibited a first peak in the late monsoon followed at some sites by another peak in early winter (November and December). This might be related to resources required for somatic maintenance and reproduction which depend on nectar plants [12].

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