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Biomonitoring of Butterfly Diversity in the CSIR-NEERI Premises, Nagpur, MS, India

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Abstract: **The study presented in this paper depicts the richness of butterflies in the CSIR-NEERI Campus in Nagpur city. The biomonitoring of butterflies was conducted with the help of the 'Line Transact Method'. A total 33 species were observed belonging to five different families. The Nymphalidae family was found to have greater diversity while the family Hesperidae showed lesser diversity. The diversity is differentiated into further four strata such as Rare (R), Very Rare (VR), Common (C), and Very Common (VC) etc. The feeding processes of lepidopteran species, as well as their habitat and host plant interactions, were observed. The existence of floral diversity at the CSIR-NEERI premises supports good butterfly diversity.**

***Keywords*: Biomonitoring, butterfly, floral status, Host plant interaction**

I. INTRODUCTION

Butterflies are common all over the place, appealing and simple to notice. Both common and uncommon species can be easily identified with the assistance of accessible field guides. Butterflies are commonly viewed as extraordinary compared to another systematically examined gathering of other insects (Robbins & Opler, 1997). Worldwide there are more than 28,000 types of butterflies, with around 80% found in tropical districts (Nair et al, 2014). The Indian sub-locale has around 1,504 types of butterflies (Roy et al. 2010; Kunte 2009; Gaonkar 1996; Smetacek 1992) among a total of 177 species were observed in the past Central Provinces (presently Madhya Pradesh, Chhattisgarh and Vidarbha) (D'Abreau, 1931; Tiple, 2011). In terms of living space quality and anthropogenic disturbing influence, butterflies are pointer taxa (Kocher & Williams 2000). Butterflies are wanton spineless creatures that are effortlessly influenced by changes in the atmosphere and like most creatures their dissemination also is greatly influenced by these changes (Kehimkar, 2008; Kumar, 2011). Butterflies are a significant part of biological systems for them to associate with plants as pollinators and herbivores (Tiple et al. 2005; Tiple, 2012). Butterflies play a significant role in the food chain, being mainly herbivores on one hand and prey to their predators like amphibians, reptiles, birds and mammals, on the other (Gupta and Mondal, 2005; Bonebrake et al., 2010). Butterflies are cosmopolitan and record over 17000 species everywhere in the world (Kumar, 2008; Farooq & Arya, 2018).

The life cycle of butterflies is dependent on their host plants hence the host plants play an important role. Along with that, the temperature and seasonal variations are also factors for the diversity of species (Padhye et al. 2006). The Lepidoptera are phytophagous. There is a link between the plant's diversity and insects also for their survival there is always a struggle between plants and insects (Mitter et al, 1988; Dawkins & Krebs, 1979). The Nymphalidae consists of 6000 species (Van Nieukerken et al. 2011). It has been studied that the species of the Pieridae family generally feed on Brassicales, Fabales and Santalales, etc. (Braby and Trueman, 2006). The particular species of butterflies are depending on particular plants. Their larval stage depends on several factors such as nutrition of the plant, toxicity, predation, parasitism and environmental changes as well as the butterflies which could consume one or multiple plant species (Wiklund and Friberg, 2009). The larvae feed on herbs, weeds, bushes, grasses, and vegetables (Tiple et al. 2011). The diversity of butterflies will be enhanced due to exposure to light and a variety of plants (Sparks, et al. 1996).

The whole NEERI Campus is surrounded by a lot of species of trees. It is one of the green regions of Nagpur. NEERI constitutes a variety of plant species such as grass, flowering plants, fruit trees and other huge trees. It comprises approximately around 150 species of trees. Some species are very common such as *Ficus religiosa,* Bamboo, *Monsoon longifolium, Delonix regia, Prunus ramonensis, Roystonea*

regia, Bougainvillea, Sulphur Cosmos, Peltophorum pterocarpum, and many any other species.

Nagpur city is situated at the specific focus of the Indian landmass. The city lies on the Deccan plateau of the Indian Peninsula and has a mean elevation of 310.5 meters above sea level. The average annual rainfall in the Nagpur district is 1064.1 mm. The winter season starts from November to January. The average temperature of the winter season is about 14°C. Nagpur city is covered with a great variety of biological systems according to seasons. The principal regular environment types are backwoods, mountains, streams, wetlands etc.

II. Material and Methods

The data has been collected at NL - 21º7′16" EL - 79º4′18" from CSIR NEERI, Nagpur. The monitoring of the butterfly was done at 10.30 am at a temperature of approximately 26°C. Data was collected by 'The Line Transect Method' (Pollard & Yates, 1993; Kim & Kown, 2013). The data is collected by counting butterflies for 30 min. The observations have been noted for the past year. The weekly observation has been taken for the study. Along with the identification of butterflies the activities of life stages of butterflies were also noted. The feeding activities of butterflies have been noted and their life stages depend on particular plant.

III. Results and Discussions

A total of 33 species of butterflies belonging to five families namely Nymphalidae, Lycaenidae, Hesperidae, Papilionidae, and Pieridae were found at the CSIR-NEERI, Nagpur campus. The number of genera observed was 21 to which these 33 species belonged. The sequential order of diversity of butterflies belonging was observed as Nymphalidae > Pieridae > Papilionidae > Lycaenidae > Hesperidae. Percentages of butterfly families present in the study area are depicted in figure 1. The status of the observed butterflies was recorded. Rare (R), Very Rare (VR), Common (C), and Very Common (VC) are the four classifications for the status of species diversity. Very Rare (VR= Species encountered <2), Rare (R= Species encountered 3-10), fairly Common (FC= species encountered 11-30), and Common (C= Species encountered >30) are the four groups of status (Tiple et al., 2005; Tiple, 2012; Shrestha et al., 2018). The percentage of the status of observed butterflies is shown in figure 2. Among all the species observed in NEERI Campus, 36% were Rare, 30% were very rare, 22% were common and the remaining 12% were fair Common.

In Table 1, the biological and common names of various butterfly species belonging to different families were mentioned. 15 species from the Nymphalidae family were observed on the NEERI campus. The species which were discovered included *Junonia lemonias* (Lemon pansy), *Junonia almana almanac* (Oriented peacock pansy), *Junonia atlites* (Grey pansy), *Junonia orithiya* (Blue pansy), *Junonia iphita* (Chocolate pansy), *Danaus genutia* (Stripped tiger), *Danaus chrysippus* (Plain tiger), *Tirumala limniaceae* (Blue tiger), *Parantica aglea* (Glassy tiger), *Acraea violae* (The tawny castor), *Neptis hylus* (Common sailer), *Ariadne merione* (Common castor), *Euploea core* (Common indian crow butterfly), *Hypolimnas misippus* (Danaid eggfly) and *Moduza procris* (Brush-footed butterfly). Pieridae family included 8 species namely, *Eurema hecabe* (Common grass yellow), *Eurema laeta* (Spotless grass yellow), *Eurema andersonii* (One spot grass yellow, *Eurema brigitta* (Small grass yellow), *Catopsilla pyranthe* (Mottled emigrant), *Catopsilla Pomona* (Common emigrant), *Pareronia hippie* (Indian wanderer), and *Appias albino* (Common albatross). 6 species of Papilionidae family were observed including *Graphium agamemnon* (Tail jay), *Graphium sarpedon* (Common bluebottle), *Papilio polytes* (Common Mormon), *Papilio demoleus* (Lime swallowtail), *Pachliopta aristolochiae* (Common rose) and *Zizeeria kaasandra* (Dark grass blue). Three species of the family Lycaenidae including *Chilades parrhasius* (Small Cupid), *Chilades lajus* (Lime blue) and *Lampides boeticus* (Pea Blue) were included. Only one species of *Hesperidae* (Small Branded Swift) i.e. *Pelopidas mathia* was observed.

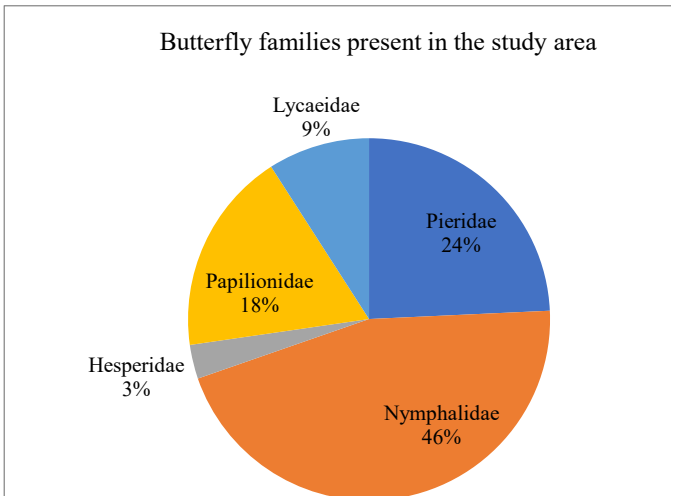

Fig. 1: Butterfly Families Present in the Study Area

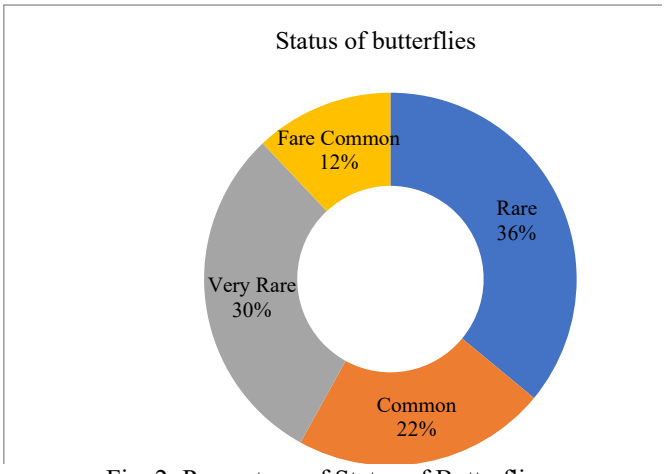

Fig. 2: Percentage of Status of Butterflies

TABLE 1
Butterfly Species Observed in NEERI Campus

Sr. No.	Family	Species	Common Name	Status
1.	Pieridae	*Eurema hecabe*	Common grass yellow	C
2.		*Eurema laeta*	Spotless grass yellow	C
3.		*Eurema andersonii*	One spot grass yellow	FC
4.		*Eurema brigitta*	Small grass yellow	R
5.		*Catopsilla pyranthe*	Mottled emigrant	C
6.		*Catopsilla pomona*	Common emigrant	FC
7.		*Pareronia hippia*	Indian wanderer	R
8.		*Appias albina*	Common albatross	R
9.	Nymphalidae	*Junonia lemonias*	Lemon pansy	C
10.		*Junonia almana almana*	Oriented peacock pansy	R
11.		*Junonia atlites*	Grey pansy	VR
12.		*Junonia orithiya*	Blue pansy	VR
13.		*Junonia iphita*	Chocolate pansy	VR
14.		*Danaus genutia*	Stripped tiger	R
15.		*Danaus chrysippus*	Plain tiger	C
16.		*Tirumala limniaceae*	Blue tiger	R
17.		*Parantica aglea*	Glassy tiger	VR
18.		*Acraea violae*	The tawny castor	C
19.		*Neptis hylus*	Common sailer	R
20.		*Ariadne merione*	Common castor	FC
21.		*Euploea core*	Common indian	C
22.		*Hypolimnas misippus*	Danaid eggfly	FC
23.		*Moduza procris*	Brush-footed butterfly	VR
24.	Papilionidae	*Graphium agamemnon*	Tail jay	R
25.		*Graphium sarpedon*	Common bluebottle	VR
26.		*Papilio polytes*	Common mormon	R
27.		*Papilio demoleus*	Lime swallowtail	R
28.		*Pachliopta aristolochiae*	Common rose	VR
29.		*Zizeeria kaasandra*	Dark grass blue	VR
30.	Lycaenidae	*Chilades parrhasius*	Small Cupid	VR
31.		*Chilades lajus*	Lime blue	R
32.		*Lampides boeticus*	Pea Blue	VR
33.	Hesperidae	*Pelopidas mathias*	Small Branded Swift	R

Tiple and Khurad, 2009 recorded a total of 145 species of butterflies in and around Nagpur City at eight various sites including Seminary Hills, Satpuda Botanical Garden, Agricultural land and Bull Rearing Center, R.T.M. Nagpur University and L.I.T. Campus, Ambazari Garden and the lakeside, national highway, Maharaj Bag, and Futala farm area. Nymphalidae family accounting for 51 species was most dominant in all those sites, followed by Lycaenidae which had 46 species, while Hesperiidae, Pieridae and Papilionidae had about 22, 17 and 9 species respectively (Tiple and Khurad, 2009). The present study also reported the species belonging to the same five families.

Patil (2014), investigated the butterfly diversity in Gorewada International Bio-Park in Nagpur, Central India. They discovered a total of 92 butterfly species, divided into 59 genera and five families. The common, occasional, and uncommon butterfly species accounted for 48.92%, 38.04%, and 13.04% of the total 92 species, respectively. The Nymphalidae family was discovered to have the most genera and species. From July to January, the highest species richness was recorded, and from late March to the last week of June, which was the lowest in the geographical area (Patil and Shende, 2014). It was per the study where Nymphalidae was the family having the highest species diversity.

Murugesan and Muthusamy (2013), surveyed and observed 103 individual butterfly species in the eastern part of the Western Ghats. The butterflies belonging to five families: Nymphalidae (32), Pieridae (23), Lycaenidae (19), Hesperiidae (15), and Papilionidae (14) were recorded, and it was found that Nymphalidae and Pieridae were the most abundant, while Hesperiidae and Papilionidae were the least abundant. Similar to their study, in the NEERI campus also family Nymphalidae was the most dominant while the family Hesperiidae was the least observed.

In the Seshachalam Biosphere Reserve, Eastern Ghats, Andhra Pradesh, India, Guptha et al. (2012), discovered 50 species of butterflies belonging to five families. Nymphalidae (20 species) was found to be the most abundant, followed by Lycaenidae (12 species), Pieridae (11 species), Papilionidae (5 species), and Hesperiidae (2 species), which was similar to the current trend.

There were a total of 17 host plant species where butterflies were continuously feeding. The family Fabaceae is responsible for the majority of butterfly species. Butterflies love the Fabaceae family of plants. There are various plant families where butterflies were less observed, such as Violaceae, Rhamnaceae, Moraceae, Rubiaceae, Magnaliaceae, Lauraceae, Verbanaceae, Amaranthaceae, Poaceae, Aristolochiae. Cappraceae, Euphorbiaceae, Malvaceae, Acanthaceae, Apocynaceae, and Rutaceae. Host plants belonging to different families are shown in Table 2.

Nectar-feeding butterflies are known to be influenced by floral characteristics. However, contrary to larvae, there is a scarcity of information about adult butterfly feeding supplies (Nimbalkar et al., 2011). From August 2007 to August 2009, Nimbalkar et al. (2011) conducted research in the Bhor Tahsil in Pune District, Maharashtra, India. There was a total of 64 butterfly species found. Nymphalidae, Lycaenidae, Pieridae, Hesperiidae, and Papilionidae were the most common families in the research area, Nymphalidae being the most dominating one. Nineteen nectar-eating plants from ten different plant families were discovered. The Asteraceae family of plants was mostly preferred by butterflies as a nectar source (Nimbalkar et al., 2011)

As indicated in Table 3, the butterfly species belonging to the family Pieridae were mostly seen to interact with trees such as *Cassia fistula*, *Capparis baducca*, *Capparis zeylanica* and *Euphorbia*. Butterflies of Nymphalidae family interact with host plant species such as *Sida cardifolia, Barleria prioritise, Calotropis gigantean, Ceropegia, Calotropis procera, Dregea volubilis, Capparis, Hybanthus enneaspermus, Dalbergia, Ziziphus, Ricinus communis, Ficus religiosa, Nerium odorum, Hemidesmus indicus, Hibiscus sp., Abutilon indicum* and *Mitragyna parviflora.* Host plants such as *Cinnamomum camphora, Aegle marmelos, Citrus, Murraya koenigii, Ruta graveolens, Chloroxylon swietenia, Aristolochia indica, Lantana camera* and *Amaranthus spinosus* were observed to host the butterfly species of Papilionidae family. While *Acacia nilotica, Dichrostachys cinerea, Citrus limon, Citrus sinensis* and *Erythrina, Butea* interact with the butterflies of Lycaenidae family. *Pelopidas mathias* of Hesperidae family prefer host trees such as *Saccharaum officinarum,* and *Cymbopogan nardus.*

TABLE 2
Plants matrix to Different Families

Sr. No.	Host plants family	Quantity
1.	Fabaceae	9
2.	Cappraceae	2
3.	Euphorbiaceae	2
4.	Malvaceae	4
5.	Acanthaceae	5
6.	Apocynaceae	4
7.	Violaceae	1
8.	Rhamnaceae	1
9.	Moraceae	1
10.	Rubiaceae	1
11.	Magnaliaceae	1
12.	Lauraceae	1
13.	Rutaceae	3
14.	Verbanaceae	1
15.	Amaranthaceae	1
16.	Poaceae	1
17.	Aristolochiae	1

TABLE 3
Butterfly Species with respect to Host Plant Species

Sr. No.	Butterfly Species	Host plant family	Host plant interaction
1	*Eurema hecabe*	Fabaceae	*Cassia fistula.*
2	*Eurema laeta*	Fabaceae	*Cassia fistula.*
3	*Eurema andersonii*	Fabaceae	*Cassia fistula.*
4	*Eurema brigitta*	Fabaceae	*Cassia fistula.*
5	*Catopsilla pyranthe*	Fabaceae	*Cassia fistula.*
6	*Catopsilla pomona*	Fabaceae	*Cassia fistula.*
7	*Pareronia hippia*	Capparaceae	*Capparis baducca, Capparis zeylanica.*
8	*Appias albina*	Euphorbiaceae	*Euphorbia.*
9	*Junonia lemonias*	Malvaceae, Acanthaceae	*Sida cardifolia, Barleria prioritise.*
10	*Junonia almana*	Malvaceae, Acanthaceae	*Sida cardifolia, Barleria prioritise.*
11	*Junonia atlites*	Acanthaceae	*Barleria prioritise.*
12	*Junonia orithiya*	Malvaceae, Acanthaceae	*Sida cardifolia, Barleria prioritise.*
13	*Junonia iphita*	Malvaceae, Acanthaceae	*Sida cardifolia, Barleria prioritise.*
14	*Danaus genutia*	Apocynaceae	*Calotropis gigantean, Ceropegia.*
15	*Tirumala limniaceae*	Apocynaceae	*Calotropis gigantean, Calotropis procera, Dregea volubilis.*
16	*Parantica aglea*	Capparaceae	*Capparis.*
17	*Acraea violae*	Violaceae	*Hybanthus enneaspermus.*
18	*Neptis hylus*	Fabaceae, Rhamnaceae	*Dalbergia, Ziziphus.*
19	*Ariadne merione*	Euphorbiaceae	*Ricinus communis.*
20	*Euploea core*	Moraceae, Acanthaceae, Apocynaceae	*Ficus religiosa, Barleria prioritise, Nerium odorum, Hemidesmus indicus.*
21	*Hypolimnas misippus*	Acanthaceae, Malvaceae	*Barleria prioritise, Hibiscus sp, Abutilon indicum.*
22	*Moduza procris*	Rubiaceae	*Mitragyna parviflora.*
23	*Graphium agamemnon*	Magnoliaceae	*Magnolia champaca.*
24	*Graphium sarpedon*	Lauraceae	*Cinnamomum camphora.*
25	*Papilio polytes*	Rutaceae	*Aegle marmelos, Citrus, Murraya koenigii, Ruta graveolens.*
26	*Papilio demoleus*	Rutaceae	*Chloroxylon swietenia.*
27	*Pachliopta aristolochiae*	Aristolochiaceae	*Aristolochia indica.*
28	*Zizeeria kaasandra*	Verbenaceae, Amaranthaceae	*Lantana camera, Amaranthus spinosus.*
29	*Chilades parrhasius*	Fabaceae	*Acacia nilotica, Dichrostachys cinerea.*
30	*Chilades lajus*	Rutaceae	*Citrus limon, Citrus sinensis.*
31	*Lampides boeticus*	Fabaceae	*Erythrina, Butea.*
32	*Pelopidas mathias*	Poaceae	*Saccharaum officinarum, Cymbopogan nardus.*

IV. CONCLUSION

The butterflies play a very important role in the environment therefore; the conservation of these species in the premises supports the food chain for the next trophic level of reptiles. The diversity of Lepidoptera depends on the variety of host plant species available in the area. Based on the checklist of butterflies of CSIR-NEERI, Nagpur the diversity of butterflies seems to be good and needs further addition of more host plant species to attract the butterflies and to boost up the ecosystem.

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