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Diversity, Seasonal Dynamics and Host Plants of Butterflies in Forest Research Centre, Siddipet, Telangana, India

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Authors' contributions

This work was carried out in collaboration among all authors. The authors make valuable contributions to the scientific community by disseminating their research findings. These findings can encompass fresh perspectives on the ecology and behaviour of butterfly populations, evaluations of how human activities affect these populations and a range of research methods such as fieldwork, experiments, data analysis to uncover patterns, or the creation of models and theoretical frameworks to elucidate observed phenomena. In the end, the collective efforts of authors in a butterfly diversity research paper serve to enhance our comprehension of these significant organisms and their ecological roles while also guiding conservation and management endeavours. All authors read and approved the final manuscript.

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ABSTRACT

Aim: This study aims at bringing out butterfly diversity through species richness, seasonal distribution and suitable host plant preferences of identified butterflies in Forest Research Centre, Siddipet, Telangana, India.

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Study Design: Line Transect Method is followed.
Place and Duration of the Study: The study was conducted in Forest Research Centre (FRC), Siddipet, Telangana, India during 2021-2022.
Methodology: Five line transects are laid across the research centre which are surveyed both in morning and afternoon at 9-11AM and 4-6PM respectively across the season viz., rainy, winter and summer seasons. Species identification was done based on the visual and photographical observations.
Results: The study revealed a butterfly species richness of 53, spanning 39 genera and distributed across five families. These families included Nymphalidae (23 species), Pieridae (12 species), Lycaenidae (10 species), Papilionoidae (6 species), and Hesperiidae (2 species). When it came to host plant preferences, the butterflies showed a preference for families such as Fabaceae (23%), Malvaceae (16%), Capparaceae (12%), Acanthaceae (11%), and Poaceae (8%). Additionally, several other families, including Apocynaceae, Aristolochiaceae, Rhamnaceae, and Rutaceae, were found to host a few butterfly species. Regarding seasonal distribution, the study noted that butterfly species were more abundant during the winter season, followed by the rainy season, with the summer season exhibiting a significant difference in distribution and occurrence compared to the other two seasons.
Conclusion: From the study, it can be concluded that FRC reported a diverse range of butterflies distributed across all the seasons making it potential site for preservation and conservation of butterflies and its host species.

Keywords: Line transect survey; abundance; host plants; forest research centre; Telangana; India.

1. INTRODUCTION

The largest category within the Arthropoda phylum is Insecta, encompassing insects, with butterflies being a particularly significant group within this category. Butterflies play a crucial ecological role, serving as valuable indicators of terrestrial ecosystem health [1]. They belong to the broader clade of macro lepidopterans known as Rhopalocera, which also includes moths within the Lepidoptera order. Butterflies, a subset of moths (Lepidoptera), offer promising opportunities for research in population and community ecology [2]. They often take centre stage in biodiversity monitoring efforts and are regarded as umbrella species in conservation [3]. Moreover, butterflies, due to their sensitivity to environmental changes, respond rapidly to alterations in factors like land use dynamics and vegetation shifts, which can impact their abundance and species composition [4,5]. Beyond this, butterfly diversity reflects seasonal and natural variations, making them excellent candidates for monitoring ecosystem health and diversity [6-8]. Therefore, regular assessments of butterfly populations can provide insights into the scope of environmental changes [9,10]. Furthermore, exploring local butterfly populations, their diversity, and seasonal patterns is essential for understanding the ecology of butterfly communities in specific regions. It also helps establish baseline data regarding this umbrella taxon within ecologically sensitive areas affected by climate change, habitat degradation/loss, and conservation efforts [11]. Studies on butterflies are imperative for enhancing their ecological utility as indicator species. There is a unique relationship between butterflies and plants [12], with butterfly diversity indirectly reflecting the overall plant diversity, especially of herbs and shrubs, in an area [13].

Butterfly studies have been conducted systematically since the early 18th century, and by 1998, approximately 19,238 butterfly species were documented worldwide [14]. India boasts a rich butterfly fauna, with a total of 1,504 species, accounting for 8.74% of the world's butterfly diversity, including 285 species found in southern India [15]. Peninsular India and the Western Ghats region are especially diverse, harbouring 351 and 334 butterfly species, respectively. Although India boasts over 1,300 butterfly species, most of them, more than 1,000 species, are concentrated in the northeastern region [16]. Telangana state, for instance, is home to 165 butterfly species across 102 genera and 6 families [17]. Hence, the present study aims to contribute to our understanding of butterfly species diversity, seasonal patterns, and host specificity within the Forest Research Centre. Additionally, it seeks to assess the state of conservation efforts in the current environmental context.

2. MATERIALS AND METHODOLOGY

2.1 Study Area

Telangana boasts a rich and diverse biodiversity, characterized by a wide variety of ecosystems [18]. On June 2, 2014, Telangana officially became the 29th state of India, covering an expansive area of 112,077 square kilometers. It shares its borders with Maharashtra and Chhattisgarh to the north, Karnataka to the west, and Andhra Pradesh to the south. Notably, the state encompasses a total forested area of 26,904 square kilometers, with a forest cover of 7,13,789 square kilometers, accounting for approximately 21.71 percent of the country's total geographical area [19]. This region comprises twelve protected areas, including seven wildlife sanctuaries, three national parks, and two tiger reserves, all of which contribute to its rich tapestry of vegetation and wildlife. Telangana has documented an impressive tally of 2,450 faunal species to date [20]. The present study was conducted at Forest Research Centre (FRC) which is situated within the state, precisely at coordinates 17°42'56" N and 17°43'15" N latitude, and 78°37'26" E and 78°38'28" E longitude, in Mulugu Mandal, Siddipet District, Telangana State, India. This sprawling centre spans 359.234 acres (1,453,777 square kilometers) and is located approximately 50 kilometers from Hyderabad. It is equipped with 141 research and development plots to facilitate scientific endeavors in the realm of forestry and natural resource management.

2.2 Transect Line Method

In this approach, we chose to investigate five transect lines within the designated campus area. Our research involved walking along these lines during the time periods of 9-11 am and 4-6 pm, carefully observing the presence of various butterfly species within the campus. We documented the species that we encountered during these walks through visual observations and photographic recordings. To facilitate the collection and interpretation of data, we divided the study year into three distinct seasons, namely (i) Rainy, (ii) Winter, and (iii) Summer [6]. This study took place between the years 2021 and 2022.

3. RESULTS AND DISCUSSION

3.1 Diversity of Butterflies among Families

Butterflies can serve as valuable indicators of biodiversity trends, with transect counts being a widely employed method for their assessment [21]. Understanding the seasonal movements of butterflies is crucial for comprehending their ecological processes [22]. In the current study, it was identified that the Forest Research Centre (FRC) recorded a total of 53 butterfly species from 5 families, all of which were meticulously photographed and documented. Among the various families observed, Nymphalidae exhibited the highest diversity, with a total of 23 species, followed by Pieridae (12 species), Papilionidae (6 species), Lycaenidae (10 species), and Hesperiidae with the fewest number of species (2 species). Within these families, 6 species were classified under Schedules I, II, and IV of the Indian Wildlife Protection Act (1972), including Common pierrot, Gram blue, Common crow, Danaid eggfly, Common gull, and crimson rose.

Table 1 presents the distribution of genera among the five families, with Nymphalidae contributing to 14 (35.9%) genera, Lycaenidae to 10 (25.6%) genera, Pieridae to 10 (25.6%) genera, Papilionidae to 3 (7.7%) genera, and Hesperiidae to 2 (5.1%) genera.

Collectively, these genera from the families Nymphalidae, Lycaenidae, Pieridae, Papilionidae, and Hesperiidae accounted for 23 (43.4%), 10 (18.9%), 12 (22.6%), 6 (11.3%), and 2 (3.8%) of the recorded species, respectively. Each family recorded varying numbers of individuals from different species, with Hesperiidae, Papilionidae, Lycaenidae, Pieridae, and Nymphalidae having 9, 124, 236, 406, and 990 individuals, respectively. The findings are consistent with those of previous studies. In [23], researchers examined butterflies inhabiting the Department of Atomic Energy (DAE) campus in Kalpakkam and discovered a total of 2177 individuals representing 56 butterfly species from the Nymphalidae, Pieridae, Lycaenidae, Papilionidae, and Hesperiidae families. Nymphalidae was the predominant family throughout all seasons. Similarly, [24] investigated butterfly diversity in relation to climatic factors at the environmental center campus of Manonmaniam Sundaranar University in Tamil Nadu, India. They identified 57 butterfly species, with Nymphalidae being the most prevalent family, followed by Lycaenidae, Pieridae, Papilionidae, and Hesperiidae. In [25], the study focused on butterfly diversity in the heterogeneous habitat of Bankura, West Bengal, India, revealing 117 butterfly species in the survey area. The highest species counts were

attributed to the Lycaenidae (30.76%) and Nymphalidae (29.91%) families, followed by Hesperiidae (16.23%), Pieridae (13.67%), Papilionidae (8.54%), and Riodinidae (0.85%). Similarly, [26] investigated the eco-sustainability of butterfly species diversity in the campus of Dr. Homi Bhabha State University, Institute of Science, Fort, Maharashtra, India, recording 39 species and 30 genera across five butterfly families, with Nymphalidae emerging as the dominant taxonomic family. The results from [27] indicated that among the 20 recorded butterfly species, Nymphalidae emerged as the most prevalent family, followed by Pieridae (5 species), Papilionidae (4 species), and Lycaenidae (2 species). In a study by Sailu et al. [28], they reported a total of 41 butterfly species, with Nymphalidae being the dominant family, followed by Pieridae, Lycaenidae, Papilionidae, and Hesperiidae. These findings are consistent with [29], which also identified Nymphalidae as the most dominant family, aligning with the results of our own studies. Our research similarly reflects this trend, with the highest species abundance occurring in the spring months of February and March. However, a decline in species abundance was observed starting in the early winter months of October and November, during which Nymphalidae remained the dominant family [30]. These studies align with the findings of [31], who conducted research on butterflies in the Siruvani forests of the Western Ghats, where they observed a total of seventy-five butterfly species, representing 49 genera within the study area.

Table 1. Total number, percentage of genus, species and individuals collected per family

Family	Genus	Percentage (%)	No of species	Percentage (%)	No of individuals	Percentage (%)
Lycaenidae	10	25.6	10	18.9	236	13.4
Hespariidae	2	5.1	2	3.8	9	0.5
Nymphalidae	14	35.9	23	43.4	990	56.1
Papilionoidae	3	7.7	6	11.3	124	7.0
Pieridae	10	25.6	12	22.6	406	23.0
Total	39	100	53	100	1765	100

3.2 Host Specificity of Butterflies

Table 2. List of butterflies observed in FRC campus

S. No.	Common Name	Host plants	Wildlife Protection Act, 1972 Status
Lycaenidae			
1	Common pierrot	*Ziziphus jujuba, Ziziphus oenopolia, Ziziphus xylopyrus*	SCHEDULE-I(PART-IV)
2	Common silverline	*Carissa carandas, Cadaba fruticosa, Diospyros melanoxylon, Cassia fistula, Ziziphus jujuba.*	
3	Dark grass blue	*Amaranthus spinosus, Amaranthus, Geissaspis cristata, Zornia diphylla, Oxalis corniculate.*	
4	Forget-me-not	*Acacia nilotica, Acacia chundra, Butea monosperma, Desmodium oojeinense, Pongamia pinnata, Tephrosia purpurea.*	
5	Gram blue	*Acacia nilotica, Butea monosperma, Cajanus cajan, Desmodium oojeinense.*	SCHEDULE-I(PART-II)
6	Indian common cerulin	*Abrus precatorius, Butea monosperma, Pongamia pinnata, Saraca asoca, Xylia xylocarpa.*	
7	Plains Cupid	*Cycas circinalis, Acacia nilotica, Bauhinia vahlii, Bauhinia variegata, Butea monosperma, Saraca asoca, Schleichera oleosa, Desmodium oogenesis.*	
8	Red Pierrot	*Bryophyllum pinnatum*	
9	Tiny grass blue	*Dipteracanthus prostratus, Hygrophila auriculata, Vicia spp, Lantana camara,*	

S. No.	Common Name	Host plants	Wildlife Protection Act, 1972 Status
		Tribulus terrestris.	
10	Zebra blue	*Abrus precatorius, Albizia lebbeck, Dalbergia lanceolaria, Indigofera tinctorea, Mimosa pudica, Mimosa hamata, Plumbago zeylanica*	
Hespariidae			
11	Indian skipper	*Hibiscus rosa-sinensis, Sida acuta, Urena lobata, Waltheria indica.*	
12	Variable swift	*Brachiaria mutica, Imperata cylindrica, Oryza sativa, Saccharum officinarum.*	
Nymphalidae			
13	Baronet	*Mangifera indica, Diospyros melanoxylon, Grewia asiatica.*	
14	Black rajah	*Dalbergia sissoo, Pithecellobium dulce, Tamarindus indica.*	
15	Blue pansy	*Barleria prionitis, Hygrophila auriculata, Justicia prostrata, Lepidagathis cristata, Mimosa pudica.*	
16	Blue tiger	*Holarrhena pubescens, Asclepias curassavica, Calotropis gigantea, Calotropis procera, Dregea volubilis, Tylophora indica.*	
17	Chocolate pansy	*Barleria cristata, Dipteracanthus prostratus, Hygrophila auriculata, Justicia micrantha*	
18	Commander	*Cadaba fruticosa, Grewia asiatica, Mitragyna parvifolia, Neolamarckia cadamba.*	
19	Common Castor	*Ricinus communis*	
20	Common crow	*Carissa spinarum, Cascabela thevetia, Holarrhena pubescens, Ichnocarpus frutescens, Nerium oleander, Tylophora indica, Ficus benghalensis, Ficus religiosa,*	*SCHEDULE-IV*
21	Common evening brown	*Apluda mutica, Eleusine indica, Pennisetum purpureum.*	
22	common four ring	*Eleusine indica*	
23	Common leopard	*Gymnosporia emerginata, Flacourtia indica*	
24	Common nawab	*Acacia catechu, Acacia chundra, Albizia lebbeck, Caesalpinia bonduc, Delonix regia, Pithecellobium dulce, Grewia tilifolia, Grewia asiatica, Helicteres isora.*	
25	Common palmfly	*Caryota urens, Dypsis lutescens, Cocos nucifera, Phoenix spp.*	
26	Common sailor	*Bombax ceiba, Xylia xylocarpa, Corchorus capsularis, Grewia tilifolia, Grewia asiatica, Helicteres isora, Triumfetta rhomboidei.*	
27	Danaid eggfly	*Barleria cristata, Ipomoea carnea, Abelmoschus ficulneus, Abutilon indicum, Abutilon hirtum, Hibiscus Lobatus, Sida cordifolia, Portulaca oleracea.*	*SCHEDULE-II (PART-II)*
28	Dark evening brown	*Apluda mutica, Bambusa bambos, Cymbopogon flexuosus, Eragrostis tennela, Panicum maximum, Pennisetum purpureum, Setaria pumilus, Seteria verticillate.*	
29	Great eggfly	*Alternanthera sessilis, Sida rhombifolia, Portulaca oleracea, Solanum nigrum.*	

S. No.	Common Name	Host plants	Wildlife Protection Act, 1972 Status
30	Grey pansy	*Barleria prionitis, Hygrophila auriculata.*	
21	Lemon pansy	*Barleria Prionitis, Hygrophila auriculata, Corchorus capsularis, Sida rhombifolia.*	
32	Peacock pansy	*Barleria prionitis, Hygrophila auriculata, Oryza sativa, Pennisetum purpureum, Pennisetum glaucum, Phyla nodiflora.*	
33	Striped tiger	*Cocculus. hirsuta, Holostemma ada-kodien, Marsdenia floribunda, Tylophora flexuosa.*	
34	Tawny coster	*Passiflora edulis, Passiflora foetida, Vitex pinnata*	
35	Yellow pansy	*Barleria prionitis, Hygrophila auriculata, Justicia prostrata, Ruellia prostrata, Mimosa pudica.*	
Family: Papilionoidae			
36	Blue Mormon	*Citrus maxima, Citrus limon, Glycosmis pentaphylla, Murraya koenigii.*	
37	Common lime	*Aegle marmelos, Citrus limon, Glycosmis pentaphylla, Limonia elephantum, Murraya koenigii, Ruta graveolens, Chloroxylon swietenia, Ziziphus jujuba.*	
38	Common Mormon	*Aegle marmelos, Citrus limon, Glycosmis pentaphylla, Murraya koenigii.*	
39	Common rose	*Aristolochia bracteolata, Aristolochia griffithii, Aristolochia indica, Aristolochia tagala, Thottea siliquosa, Bragantia wallichii.*	
40	Plain tiger	*Asclepias curassavica, Calotropis gigantea, Calotropis procera, Caralluma adscendens, Cryptolepis dubi, Pergularia daemia.*	
41	Tailed jay	*Annona squamosa, Miliusa tomentosa, Polyalthia longifolia*	
Pieridae			
42	Common emigrant	*Bauhinia racemosa, Butea monosperma, Cassia fistula, Dalbergia latifolia, Senna tora, Senna siamea, Sesbania grandiflora.*	
43	Common gull	*Cadaba fruticosa, Capparis sepiaria, Capparis zeylanica, Maerua oblongifolia*	*SCHEDULE-II (PART-II)*
44	Common jezebel	*Butea monosperma, Dendrophthoe falcata, Loranthus longiflorus, Helicanthes elasticus, Abelmoschus moschatus, Pterospermum acerifolium.*	
45	Crimson rose	*Aristolochia bracteolata, Aristolochia griffithii, Aristolochia indica, Aristolochia tagala.*	*SCHEDULE-I (PART-IV)*
46	Crimson tip	*Cadaba fruticosa, Maerua oblongifolia, Capparis divaricata, Capparis sepiaria.*	
47	Common wanderer	*Capparis baducca, Capparis zeylanica.*	
48	Indian pioneer`	*Capparis baducca, Capparis divaricata, Capparis sepiaria, Capparis spinosa, Capparis zeylanica, Maerua oblongifolia, Cadaba fruticose.*	
49	Small grass yellow	*Chamaecrista kleinii, Cassia javanica, Cassia fistula.*	
50	Mottled emigrant	*Cassia fistula, Cassia javanica, Senna auriculata, Senna tora, Senna occidentali.*	
51	Psyche	*Capparis baducca, Capparis spinosa, Capparis zeylanica, Cleome viscosa.*	

S. No.	Common Name	Host plants	Wildlife Protection Act, 1972 Status
52	White orange tip	*Capparis decidua, Capparis divaricata, Capparis grandis, Capparis sepiaria, Cadaba fruticosa.*	
53	Yellow orange-tip	*Capparis divaricata, Capparis sepiaria, Capparis zeylanica.*	

Table 2 illustrates the host plant preferences of butterflies, indicating that the majority (23%) of butterflies tend to use plants from the Fabaceae family as hosts, followed by the Malvaceae family (16%), Capparaceae (12%), Acanthaceae (11%), and Poaceae (8%). These findings align with the results of other studies, such as those conducted by [32], which also found that butterflies demonstrate host specificity, primarily favouring plants from the Fabaceae and Poaceae families. Additionally, these investigations revealed that the population size of butterflies is influenced by the number of host plants they utilize.

3.3 Seasonal Variability of Butterflies

Table 3 provides insights into the occurrence of butterflies from different families during various seasons, namely the rainy season, winter, and summer. Among these, the Nymphalidae family exhibited the highest occurrence during both winter (20 instances) and the rainy season (20 instances), while it had a slightly lower count in summer with 15 instances. This family demonstrated the greatest number and diversity of butterflies during the monsoon, which could be attributed to the abundant growth of their host plants [33]. Following closely, the Pieridae family was the next in occurrence, with 11 instances during winter, 10 during summer, and 9 during the rainy season. This pattern might be due to the presence of plants from the Capparaceae and Caesalpiniaceae families, which are known to support the Pieridae family abundantly [34]. The Lycaenidae family had 7 occurrences during both the rainy season and winter, and 5 occurrences during summer. Meanwhile, the Papilionoidae family had 6 occurrences each during both winter and summer, and 5 occurrences during the rainy season. Conversely, the Hespariidae family had fewer instances, with only 2 occurrences in the rainy and winter seasons, and just 1 occurrence recorded during the summer season.

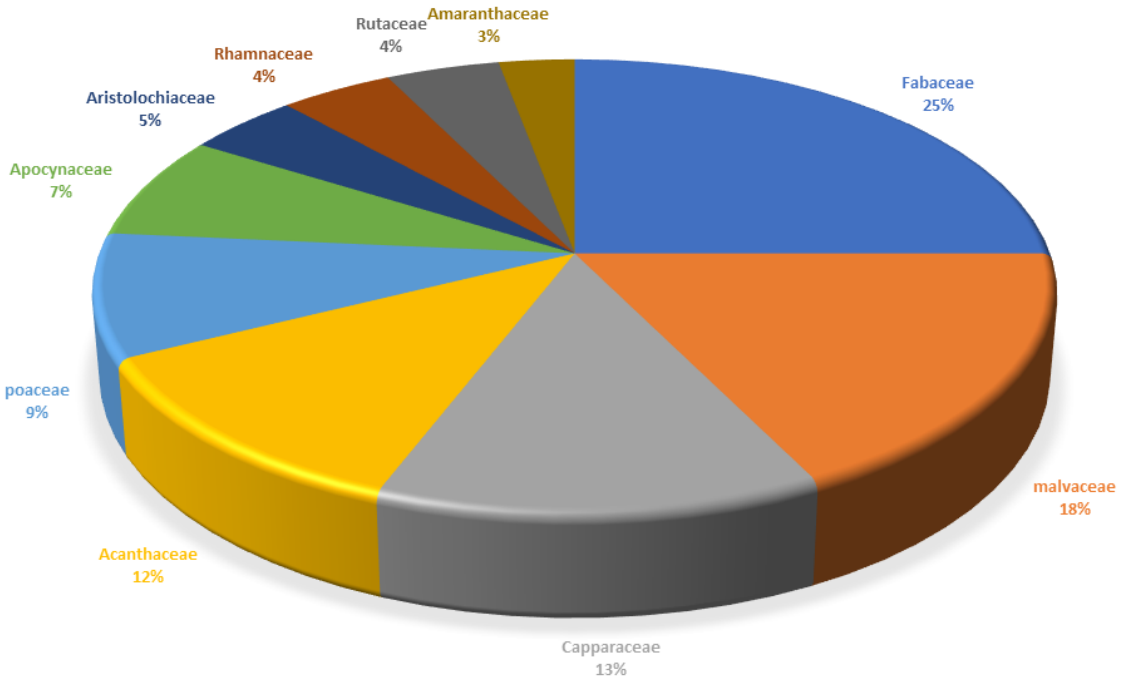

Fig. 1. Top host plant families

Table 3. Seasonal abundance (mean) of butterfly species recorded in FRC

S.No.	Scientific Name	Common Name	Observed in months
1	*Castalius rosimon* (Fabricius, 1775)	Common pierrot	Jan, Oct, Nov
2	*Spindasis vulcanus* (Fabricius, 1775)	Common silverline	Feb, March, June, July
3	*Zizeeria karsandra* (Moore, 1865)	dark grass blue	April, Sept
4	*Catochrysops strabo* (Fabricius, 1793)	forget-me-not	Sept
5	*Euchrysops cnejus* (Fabricius, 1798)	Gram blue	Jan, April, Sept
6	*Jamides celeno* (Cramer, [1775])	Indian common cerulin	Sept and oct
7	*Chilades pandava* (Horsfield, [1829])	Plains Cupid	Except April, may, june
8	*Talicada nyseus* (Guérin-Méneville, 1843)	Red Pierrot	Jan, Oct, Nov
9	*Zizula hylax* (Fabricius, 1775)	Tiny grass blue	Dec, Jan, Feb
10	*Leptotes plinius* (Fabricius, 1793)	Zebra blue	Sept and oct
11	*Spialia galba* (Fabricius, 1793)	Indian skipper	Sept and oct
12	*Pelopidas mathias* (Fabricius, 1798)	Variable swift	Except April, may, june
13	*Symphaedra nais* (Forster, 1771)	Baronet	All months
14	*Charaxes solon* (Fabricius, 1793)	Black rajah	Sept and oct
15	*Junonia orithya* (Linnaeus, 1758)	Blue pansy	Dec
16	*Tirumala limniace* (Cramer, [1775])	Blue tiger	All months
17	*Junonia iphita* (Cramer, [1779])	Chocolate pansy	All months
18	*Moduza procris* (Cramer, [1777])	Commander	Except Apr, Jun
19	*Ariadne merione* (Cramer, [1777])	Common Castor	All months
20	*Euploea core* (Cramer, [1780])	Common crow	All months
21	*Melanitis leda* (Linnaeus, 1758)	Common evening brown	Except Jan, Mar, Jun, Sep
22	*Ypthima huebneri* (Kirby, 1871)	common four ring	Except Apr, Jun
23	*Phalanta phalantha* (Drury, [1773])	Common leopard	Except May, Jul, Sep
24	*Charaxes bharata* C. & R. Felder, [1867]	Common nawab	Feb, Jul, Aug, Dec
25	*Elymnias hypermnestra* (Linnaeus, 1763)	Common palmfly	Aug, Sept
26	*Neptis hylas* (Linnaeus, 1758)	Common sailor	Except Apr
27	*Hypolimnas misippus* (Linnaeus, 1764)	Danaid eggfly	All months
28	*Melanitis phedima* (Cramer, [1780])	Dark evening brown	Sept, Nov
29	*Hypolimnas bolina* (Linnaeus, 1758)	Great eggfly	Except Apr, Jun
30	*Junonia atlites* (Linnaeus, 1763)	Grey pansy	Aug, Sept, nov
31	*Junonia lemonias* (Linnaeus, 1758)	Lemon pansy	Except Mar, Jun, Sep
32	*Junonia almana* (Linnaeus, 1758)	Peacock pansy	July, Oct
33	*Danaus genutia* (Cramer, [1779])	Striped tiger	Except Jul, Nov
34	*Acraea terpsicore* (Linnaeus, 1758)	Tawny coster	June, Aug, Oct, Dec
35	*Junonia hierta* (Fabricius, 1798)	Yellow pansy	Jan-Apr, Oct, Dec
36	*Papilio polymnestor* (Cramer, 1775)	Blue Mormon	Except Jun, Jul
37	*Papilio demoleus* (Linnaeus, 1758)	Common lime	Except Jan, Nov
38	*Papilio polytes* (Linnaeus, 1758)	Common Mormon	All months
39	*Pachliopta aristolochiae* (Fabricius, 1775)	Common rose	All months
40	*Danaus chrysippus* (Linnaeus, 1758)	Plain tiger	Except Apr, Nov
41	*Graphium agamemnon* (Linnaeus, 1758)	Tailed jay	Except Jan, Jul, Oct
42	*Catopsilia pomona* (Fabricius, 1775)	Common emigrant	All months
43	*Cepora Nerissa* (Fabricius, 1775)	Common gull	Except Jan, Jul, Oct
44	*Delias eucharis* (Drury, 1773)	Common jezebel	Except March, April August, Nov
45	*Pachliopta hector* (Linnaeus, 1758)	Crimson rose	All months
46	*Colotis danae* (Fabricius, 1775)	Crimson tip	Except Mar, Jun, Sep
47	*Pareronia hippia* (Fabricius, 1787)	Common wanderer	Except April, Aug
48	*Belenois aurota* (Fabricius, 1793)	Indian pioneer	Except Jul, Aug, Nov
49	*Eurema brigitta* (Stoll, [1780])	Small grass yellow	All months
50	*Catopsilia pyranthe* (Linnaeus, 1758)	Mottled emigrant	Except Jan, Jul, Oct
51	*Leptosia nina* (Fabricius, 1793)	Psyche	Jan, Feb, May, Oct-Dec
52	*Ixias Marianne* (Cramer, [1779])	White orange tip	Feb, Aug, Nov
53	*Ixias pyrene* (Linnaeus, 1764)	Yellow orange-tip	Jan, May, June, Aug-Oct

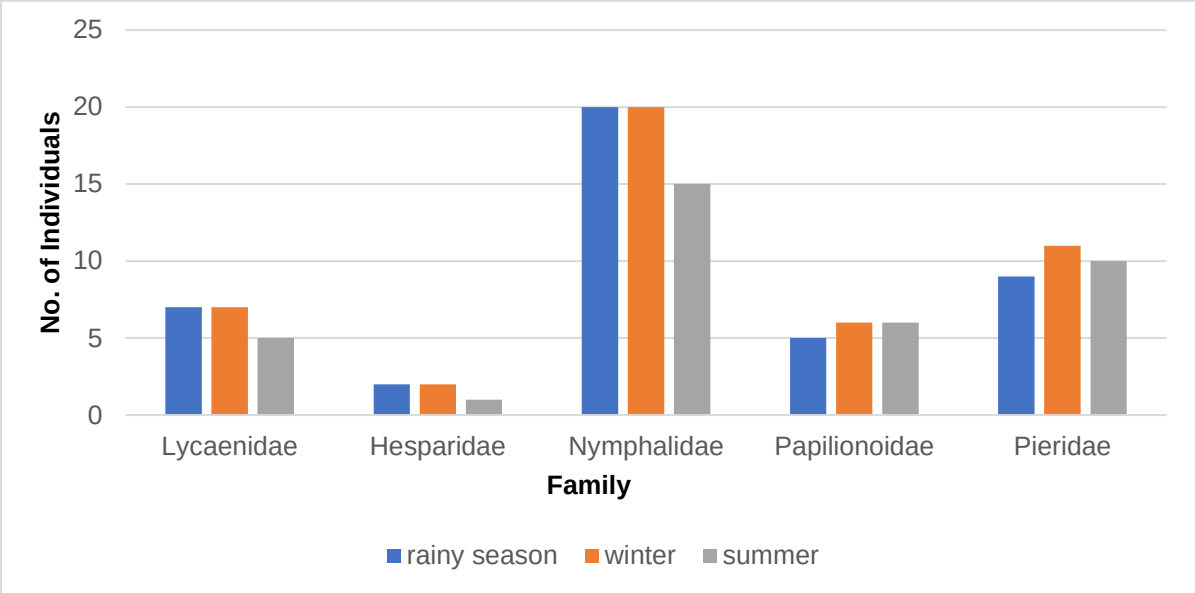

Fig. 2. Population trends of butterfly families in different seasons

Seasonal variation exerts a significant influence on species diversity, with notably higher values typically observed during the monsoon season [35]. From the data in Table 3 and Fig. 2, the study documented four families of butterflies, some of which occurred consistently throughout the seasons while others were present only during specific months of the year. In the case of Lycaenidae, the occurrence was relatively similar during both the rainy and winter seasons, with a lower occurrence in the summer. These findings contrast with those of [23] but are in proximity to the results reported by [25]. A similar trend, with respect to Hespariidae and Nymphalidae, was observed with various other studies [36,37]. However, Papilionoidae exhibited its highest number of species occurrences during the winter and summer seasons, with the rainy season recording the lowest occurrences. On the other hand, Pieridae showed a greater number of species occurrences in winter, followed by summer and the rainy season. This seasonal dynamics of Pieridae is similar to the findings reported by [23,25].

From Fig. 3, which considers the mean number of species occurrences from five different families, it is evident that the highest mean number of species occurrences was observed during the rainy and winter seasons, with a noticeable decline during the summer season. These results differ from the observations made by [38,39] but are in line with the findings reported in these studies [37,40-42].

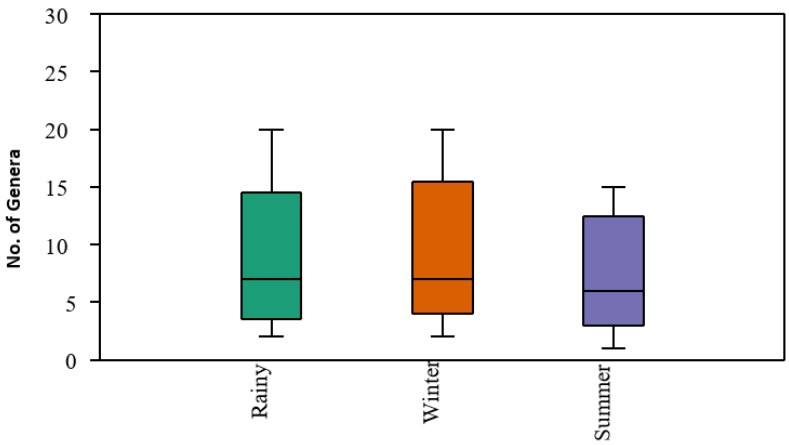

Fig. 3. Seasonal distribution of various Genera

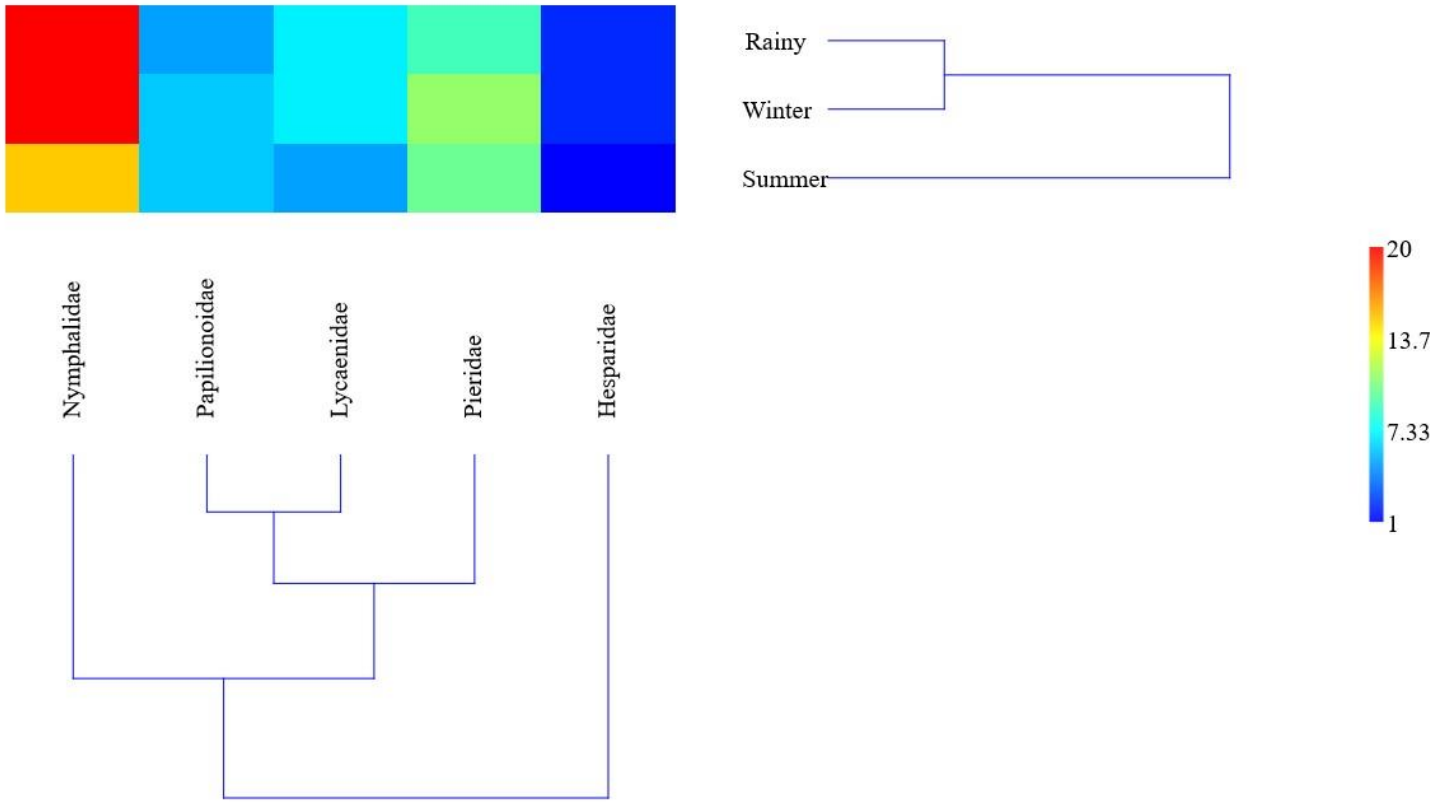

Fig. 4. Hierarchical cluster analysis of Bray-Curti's similarity index

Plate 1. A) Baronet B) Black Rajah C) Blue Mormon D) Blue Pansy E) Blue Tiger F) Variable Swift G) Chocolate Pansy H) Commander I) Indian Cerulean

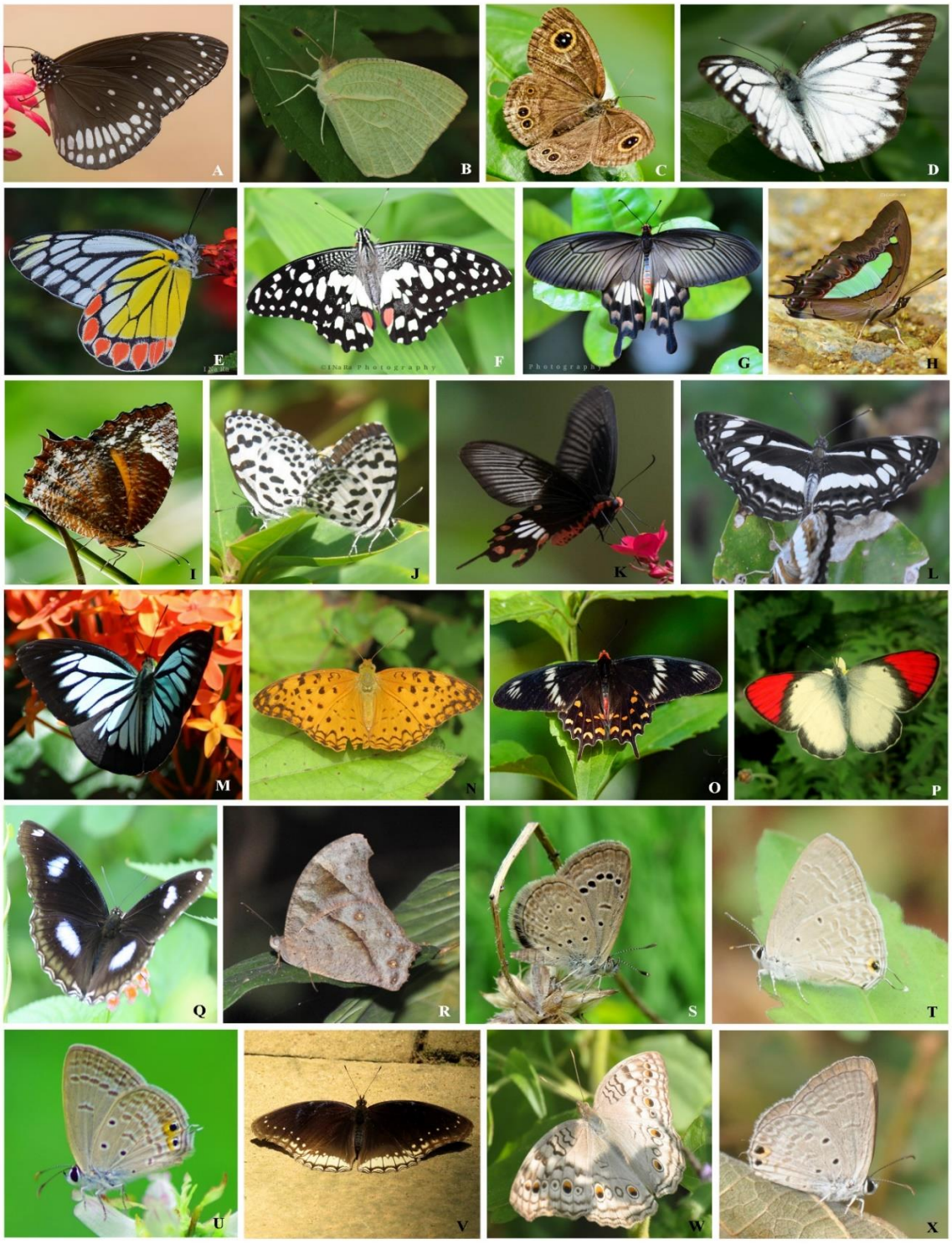

Plate 2. A) Common Crow B) Common Emigrant C) Common Four ring D) Common Gull E) Common Jezebel F) Common Lime G) Common Mormon H) Indian Nawab I) Common Palmfly J) Common Pierrot K) Common Rose L) Common Sailor M) Common wanderer N) Common Leopard O) Crimson Rose P) Crimson Tip Q) Danaid Egg Fly R) Common Evening Brown S) Dark Grass Blue T) Forgot Me Not U) Plains Cupid V) Great Egg Fly W) Grey Pansy X) Gram Blue

Plate 3. A) Indian Pioneer B) Indian Skipper C) Lemon Pansy D) Mottled Emigrant E) Peacock Pansy F) Plain Tiger G) Red Pierrot H) Common Silverline I) Small Orange Tip J) Striped Tiger K) Common Jay L) Tawny Coster M) Tiny Grass Blue N) White Orange Tip O) Yellow Orange Tip P) Zebra Blue

Plate 4. A) *Acacia nilotica* B) *Barleria prionitis* C) *Bauhinia purpurea* D) *Bauhinia vahlii* E) *Butea monosperma* F) *Calotropis gigantea* G) *Cassia fistula* H) *Dalbergia paniculata* I) *Holarrhena antidysenterica* J) *Hygrophila auriculata* K) *Lantana camara* L) *Mitragyna parviflora* M) *Polygonum pleibium*

During the hierarchical cluster analysis of the Bray-Curtis similarity index using Past 4.03 software, the study uncovered interesting patterns. It was found that the rainy and winter seasons exhibited significant similarity in terms of the number of species occurrences, while they differed in similarity from the summer season. Among the observed families, the primary similarity was observed between Papilionoidea and Lycaenidae, with these two families sharing a common similarity. These two families, in turn, had a similarity with Pieridae, and Pieridae shared similarity with Nymphalidae. Lastly, these four families (Papilionoidae, Lycaenidae, Pieridae, and Nymphalidae) collectively had a decreasing similarity with Hespariidae, with Papilionoidae showing the highest similarity and Hespariidae the lowest. This hierarchical pattern of similarity among the families provides valuable insights into their ecological relationships and interactions within the ecosystem.

4. CONCLUSION

The findings of this research highlight the rich diversity of butterflies present at the Forest Research Centre (FRC). This underscores the importance of further research on this relatively understudied group of insects within the FRC ecosystem. The focus of this research is primarily on exploring the butterflies and the specific plants they rely on as hosts. It is important to note that while certain butterfly species may be considered protected or uncommon in India, these designations may have limited applicability to the FRC specifically. India, as a nation, is home to numerous butterfly species that hold ecological significance. Therefore, it is imperative that we collaborate and take concerted efforts to safeguard this invaluable natural resource within the FRC. Preservation and conservation of butterflies and their habitats not only contribute to the protection of biodiversity but also have broader ecological and environmental implications. By working together, we can contribute to the conservation of these delicate and beautiful creatures and ensure their existence for future generations to appreciate and study.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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