International Journal of Entomology Research
www.entomologyjournals.com
E-ISSN: 2455-4758
Received: 03-10-2026, Accepted: 02-11-2026, Published: 17-11-2026
Volume 11, Issue 4, 2026, Page No. 256-261

Seasonal dynamics and community structure of butterflies (Lepidoptera: Rhopalocera) in the Tungarli Lake landscape of the Northern Western Ghats, Maharashtra, India

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DOI: https://doi.org/10.66856/ijer.2026.11.4.11404

Abstract
Butterflies are sensitive to the change in vegetation and resources, and thus, make good indicators for biodiversity and ecological assessments. This paper evaluates the diversity, abundance and seasonal variations in butterfly populations in the Tungarli lake area, Lonavala, Maharashtra, India. Observation technique was employed to record species distribution and abundance per month, while community structure was analyzed based on species richness, Shannon-Wiener diversity index, Simpson's diversity and dominance and Pielou's evenness index. In total, 44 butterfly species belonging to five different families (Papilionidae, Pieridae, Nymphalidae, Lycaenidae and Hesperiidae) were identified in the study area, with 952 individual butterflies were recorded throughout the year. Papilionidae had the highest number of species (11, 25.00%) and individuals (257, 27.00%). Abundance per month increased from 47 individuals in January to 129 individuals in November, whereas richness per month increased from 33 species in January to 44 species in November. Shannon-Wiener diversity index varied between 3.149 in May and 3.488 in October and November. Simpson's diversity index (1 – D) ranged from 0.9522 to 0.9656, while the Pielou's evenness index ranged between 0.939 and 0.983. This increase in both abundance and species richness in the latter half of the season suggests clear seasonal structuring of the butterfly assemblage. The results give basic data on the butterfly community in the Tungarli Lake ecosystem, indicating that the importance of seasonal observations must be considered in studying changes in the butterfly diversity in the northern Western Ghats of Maharashtra.

Keywords: Butterflies, Lepidoptera, biodiversity, seasonal variation, species richness, Shannon–Wiener index, Simpson's index, Pielou's evenness, Tungarli Lake, Maharashtra

Introduction

Butterflies are an essential part of terrestrial biodiversity and are strongly linked with habitat structure, presence of larval host plants, nectar availability, microclimatic features and seasonality in habitat attributes. As a consequence of their comparatively short generation cycles, vulnerability to habitat conditions and reliance on certain plant resources during various life stages, butterfly faunas can be informative tools for ecological studies (Bonebrake *et al.*, 2010) [1]. Therefore, systematic investigation of butterfly faunas can serve as a source of baseline data for biodiversity assessments and ecological monitoring.

Indian butterfly fauna is very diverse with considerable variability in the species composition of biogeographic regions and different habitats. The Western Ghats region is especially significant for butterfly diversity due to its complex relief, climate zones, vegetation variability and rich biodiversity. Research in the Western Ghats has revealed significant differences in butterfly abundance and species composition between habitats and seasons (Kunte, 1997; Kunte *et al.*, 1999) [8, 10]. It means that butterfly assessments performed during a limited time period cannot reflect the dynamics of local faunas.

Seasonality is another factor that affects butterfly abundance and species richness. Variations in rainfall, temperature, humidity, growth of vegetation and food availability can affect the emergence, reproduction, larval development and availability of nectar. Kunte (1997) [8] noted the effects of seasonality on butterfly abundance and species diversity in tropical habitats of the northern Western Ghats. Likewise, Padhye *et al.*, (2006) [13] found considerable seasonal and landscape-related variability in butterfly populations at Tamhini in the northern Western Ghats of Maharashtra. Most recently, Naik *et al.*, (2022) [11] highlighted the seasonal variability in butterfly abundance and richness in central Western Ghats, highlighting the need for repeat surveys to determine baseline patterns of butterfly populations.

Butterfly populations can also be affected by the heterogeneity of the landscape and anthropogenic disturbance. Habitat heterogeneity can lead to differences in the availability of host plants, nectar sources, shelter and microhabitats. As seen from the research done in the Western Ghats, the butterfly communities can vary greatly within different habitat types and observations at the community level can be very helpful in providing a baseline pattern (Naik *et al.*, 2022) [11].

Quantitative measures of species diversity offer a tool for providing a description of community structure through a species list alone. Species richness refers to the number of species documented in the study, while the diversity indices include information about species richness and distribution of individuals amongst species. Shannon diversity index is used to measure community diversity, and the Simpson's index gives information on dominance and diversity. The evenness by Pielou provide information on the distribution of individuals among the different species (Shannon, 1948; Pielou, 1966) [14, 15]. Therefore, these measures can help in investigating temporal changes in butterfly communities.

Although the Western Ghats possess high ecological importance, much of the baseline information on the landscape and semi-natural habitats is still lacking.

Repeated and long-term biodiversity surveys are especially helpful as they can give information on seasonal presence and abundance which cannot be gained from a one-off survey. Recent studies from the Western Ghats have also highlighted the importance of baseline surveys to understand the butterfly communities.

The current study has been conducted to provide details on the diversity of butterflies and their monthly variation in abundance in Tungarli Lake, Lonavala, Maharashtra. This study is primarily meant to (i) identify the species of butterflies found in the study area, (ii) estimate the monthly abundance and richness of species, (iii) analyze the composition of families in terms of the recorded butterfly assemblage, and (iv) study the temporal variation in community diversity based on the Shannon-Wiener diversity index, Simpson's diversity and dominance indices and Pielou's evenness index.

Materials and Methods

Study Area

The study was conducted at Tungarli Lake, Lonavala, Maharashtra, India, which lies in the northern part of Western Ghats. The Tungarli Lake ecosystem includes the lake and its surroundings, thus forming an environment that is heterogeneous enough to support various butterflies. The study was conducted from January 2025 to December 2025. Random sampling was done to document butterflies. Field observation were carried out four times per month. Observation was recorded every Sunday from 7.00 AM to 10.00 AM. species were identified directly in the field or, in difficult cases, following capture or photography. Butterflies were identified from Wynter-Blyth (1957), Gay *et al.*, (1992), Kunte (2000), and Varshney (1983) [4, 9, 16, 17]. Monthly data consisted of individual numbers of each butterfly species observed and the total number of butterfly species observed each month. This data was then used to generate the butterfly by month abundance data. Identification of butterfly species was done on the basis of external morphological characters.



Fig 1: Map of Tungarli lake area (Google Earth)

The monthly number of butterfly individuals was determined by totaling the individuals of all species for that month. Monthly species richness (S) was defined as the total number of butterfly species recorded for that month.

Shannon–Wiener diversity index

The diversity of butterflies per month was calculated on the basis of the Shannon-Wiener diversity index:

$$H' = -\Sigma\ pi \ln (pi)$$

Where pi is the proportion of individuals representing the i th species in the particular month. The exact formula by Shannon was the starting point for the calculation (Shannon, 1948) [15].

Simpson's diversity and dominance

The Simpson's dominance index was calculated as:

$$D = \Sigma\ pi^2$$

Where pi is the proportion of individuals representing the i th species.

The Simpson's diversity was determined as follows:

$$1 - D$$

Greater values of 1 − D correspond to greater diversity, while greater values of D show higher concentration of individuals in fewer species.

Pielou's evenness:

The evenness of species was calculated using the Pielou evenness index:

$$J' = H' / \ln(S)$$

Where H' is the Shannon-Wiener diversity index and S is the number of species recorded in the corresponding month. The index ranges from 0 to 1 theoretically; close values to 1 indicate high evenness of individuals within the recorded species.

Result

A total of 44 butterfly species were observed from the study site throughout the 12-month study period. The total number of butterfly individuals observed each month was 952. The observed butterfly species constituted commonly occurring butterfly species with a high variability in their monthly abundance and frequency of occurrence.

The number of individuals recorded for each species ranged between 2 and 50. The maximum number of individuals observed was that of Euploea core (50), Tirumala limniace (47), Papilio polytes (43) and Papilio demoleus (43). Similarly, Pachliopta aristolochiae (42) and Ixias pyrene (42) had 42 individuals each. The minimum number of individuals observed was that of Ypthima huebneri (2), Acytolepis puspa (3), Curetis thetis (3) and Taractrocera ceramas (3). Table 1.

Table 1: Butterfly species recorded during study

Sr. No.	Scientific name	Common name	Family
1	*Papilio polymnestor* (Cramer, 1775)	Blue Mormon	Papilionidae
2	*Papilio polytes* (Linnaeus, 1758)	Common Mormon	Papilionidae
3	*Graphium agamemnon* (Linnaeus, 1758)	Tailed Jay	Papilionidae
4	*Graphium doson* (C. & R. Felder, 1864)	Common Jay	Papilionidae

5	*Graphium sarpedon* (Linnaeus, 1758)	Common Bluebottle	Papilionidae
6	*Pachliopta aristolochiae* (Fabricius, 1775)	Common Rose	Papilionidae
7	*Papilio demoleus* (Linnaeus, 1758)	Lime Butterfly	Papilionidae
8	*Pachliopta hector* (Linnaeus, 1758)	Crimson Rose	Papilionidae
9	*Papilio clytia* (Linnaeus, 1758)	Common Mime	Papilionidae
10	*Papilio helenus* (Linnaeus, 1758)	Red Helen	Papilionidae
11	*Troides minos* (Cramer, 1779)	Southern Birdwing	Papilionidae
12	*Appias albina* (Boisduval, 1836)	Common Albatross	Pieridae
13	*Cepora nerissa* (Fabricius, 1775)	Common Gull	Pieridae
14	*Ixias pyrene* (Linnaeus, 1764)	Yellow Orange Tip	Pieridae
15	*Appias libythea* (Fabricius, 1775)	Striped Albatross	Pieridae
16	*Eurema hecabe* (Linnaeus, 1758)	Common Grass Yellow	Pieridae
17	*Hebomoia glaucippe* (Linnaeus, 1758)	Great Orange Tip	Pieridae
18	*Pareronia valeria* (Cramer, 1776)	Common Wanderer	Pieridae
19	*Eurema laeta* (Boisduval, 1836)	Spotless Grass Yellow	Pieridae
20	*Belenois aurota* (Fabricius, 1793)	Pioneer	Pieridae
21	*Catopsilia pomona* (Fabricius, 1775)	Lemon Emigrant	Pieridae
22	*Junonia almana* (Linnaeus, 1758)	Peacock Pansy	Nymphalidae
23	*Danaus chrysippus* (Linnaeus, 1758)	Plain Tiger	Nymphalidae
24	*Junonia atlites* (Linnaeus, 1763)	Grey Pansy	Nymphalidae
25	*Junonia iphita* (Cramer, 1779)	Chocolate Pansy	Nymphalidae
26	*Junonia lemonias* (Linnaeus, 1758)	Lemon Pansy	Nymphalidae
27	*Ariadne merione* (Cramer, 1777)	Common Castor	Nymphalidae
28	*Euploea core* (Cramer, 1780)	Common Crow	Nymphalidae
29	*Ypthima baldus* (Fabricius, 1775)	Common Five-ring	Nymphalidae
30	*Ypthima huebneri* (Kirby, 1871)	Common Four-ring	Nymphalidae
31	*Tirumala limniace* (Cramer, 1790)	Blue Tiger	Nymphalidae
32	*Acytolepis puspa* (Horsfield, 1828)	Common Hedge Blue	Lycaenidae
33	*Pseudozizeeria maha* (Kollar, 1844)	Pale Grass Blue	Lycaenidae
34	*Lampides boeticus* (Linnaeus, 1767)	Pea Blue	Lycaenidae
35	*Zizeeria karsandra* (Moore, 1865)	Dark Grass Blue	Lycaenidae
36	*Castalius rosimon* (Fabricius, 1775)	Common Pierrot	Lycaenidae
37	*Caleta decidia* (Hewitson, 1876)	Angled Pierrot	Lycaenidae
38	*Curetis thetis* (Drury, 1773)	Indian Sunbeam	Lycaenidae
39	*Udaspes folus* (Cramer, 1775)	Grass Demon	Hesperiidae
40	*Iambrix salsala* (Moore, 1866)	Chestnut Bob	Hesperiidae
41	*Taractrocera ceramas* (Hewitson, 1868)	Tawny-spotted Grass Dart	Hesperiidae
42	*Pelopidas agna* (Moore, 1865)	Little Branded Swift	Hesperiidae
43	*Ampittia dioscorides* (Fabricius, 1793)	Common Bush Hopper	Hesperiidae
44	*Pelopidas mathias* (Fabricius, 1798)	Small Branded Swift	Hesperiidae

Table 2: Monthly variation in butterfly abundance

Sr. No.	Month	Individual record	Species richness
1	January	47	33
2	February	54	34
3	March	57	35
4	April	56	35
5	May	56	35
6	June	69	40
7	July	81	40
8	August	106	43
9	September	113	43
10	October	119	42
11	November	129	44
12	December	65	37

The lowest number of individuals per month was recorded in January (47 individuals), whereas highest was noted in November (129 individuals). The species richness showed an increasing trend through time until the later part of the observations. The highest number of species richness was noted in November, where all 44 species were present. From January to November, the number of individuals gradually increased, with some small variations noted in April and May. However, there was a considerable increase starting July up until October.

Table 3: Family-wise distribution of Butterfly species

Sr. No.	Family	Species	% of species	Individuals	%of individuals
1	Papilionidae	11	25.00	257	27.00
2	Pieridae	10	22.73	245	25.74

3	Nymphalidae	10	22.73	250	26.26
4	Lycaenidae	7	15.91	89	9.35
5	Hesperiidae	6	13.64	111	11.66
6	Total	44	100	952	100

The family Papilionidae possessed the largest number of species and also the highest number of specimens recorded (257; 27.00%). The family Nymphalidae provided 250 specimens (26.26%) while the family Pieridae gave 245 specimens (25.74%). Lycaenidae was found to provide the least number of specimens (89; 9.35%).

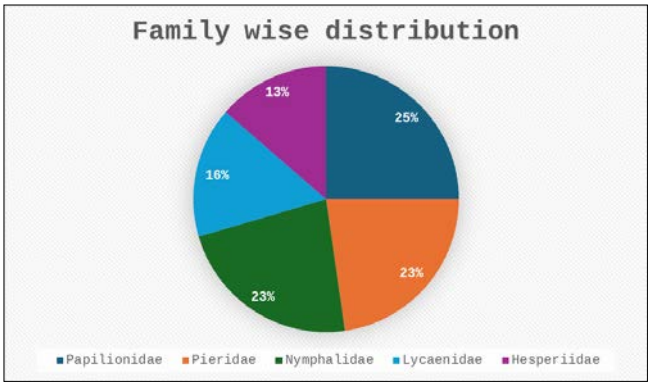


Fig 2: Showing family wise distribution of butterfly

Shannon–Wiener diversity

The Shannon–Wiener diversity index was calculated as:

$$H' = -\Sigma\ pi\ ln(pi)$$

Where pi represents the proportional abundance of species i.

Table 4: Showing Shannon–Wiener diversity

Sr. No.	Month	H′
1	January	3.367
2	February	3.308
3	March	3.331
4	April	3.369
5	May	3.149
6	June	3.320
7	July	3.256
8	August	3.365
9	September	3.469
10	October	3.488
11	November	3.488
12	December	3.307

The diversity index values calculated using the Shannon-Wiener Index for each month ranged between 3.149 (May) and 3.488 (October and November). This is because the higher numbers that characterize the months of September to November coincide with the increased number of species during those months. Notably, Shannon diversity takes into consideration both richness and relative abundance of the species.

Simpson's diversity and dominance

For transparency, I calculated both: Simpson dominance:

$$D = \Sigma pi^2$$

And

Simpson diversity:

$$1 - D$$

Table 5: Showing Simpson's diversity and dominance

Sr. No.	Month	Simpson D	Simpson 1-D
1	January	0.0367	0.9633
2	February	0.0384	0.9616
3	March	0.0391	0.9609
4	April	0.0376	0.9624
5	May	0.0478	0.9522
6	June	0.0389	0.9611
7	July	0.0428	0.9572
8	August	0.0390	0.9610
9	September	0.0355	0.9645
10	October	0.0344	0.9656
11	November	0.0353	0.9647
12	December	0.0409	0.9591

The value of Simpson's diversity (1 – D) was highest during the month of October (0.9656), whereas Simpson's dominance was highest during the month of May (0.0478). Annual Simpson diversity index was 0.9665. It shows that there was no domination by any single species in the whole year. Simpson and Shannon indices have been used previously to characterize butterfly assemblages in India.

Evenness by Pielou's formula

Pielou's Evenness was determined by using the formula:

$$J' = H'/ln(S)$$

Where S is the number of species recorded during the corresponding month.

Table 6: Showing Evenness of the species

Sr. No.	Month	Pielou J'
1	January	0.981
2	February	0.983
3	March	0.970
4	April	0.972
5	May	0.955
6	June	0.976
7	July	0.957
8	August	0.947
9	September	0.947
10	October	0.952
11	November	0.939
12	December	0.963

Pielou's evenness value varied from 0.939 in November to 0.983 in February. Evenness value for the year was 0.934. A key factor here is that while November had the highest number of species but at the same time lowest evenness value of all months. This implies that the presence of many species in November does not indicate that all of them were evenly distributed.

Discussion

The current study observed 44 species of butterflies belonging to five different families in the landscape associated with the Tungarli Lake, Lonavala, Maharashtra within the span of 12 months. This included Papilionidae, Pieridae, Nymphalidae, Lycaenidae and Hesperiidae, which

indicates that both the lake and associated terrestrial habitats are home to a diverse community of butterflies. Ecologically, it is of great significance for a relatively small landscape associated with the lake to support such a wide range of butterfly families because of the use by butterflies of many types of habitat resources, including food sources, larval hosts, vegetations and shelters. Butterfly diversity associated with habitats has been recorded at other locations within Pune District. Nimbalkar *et al.*, (2011) [12], for instance, have recorded 64 species of butterflies at Bhor Tahsil and have found an association between butterfly diversity and nectar resources. While the 44 species found at the lake Tungarli are an important number of butterflies for this particular site, care must be taken when evaluating this number since it must take into consideration the extent and length of time the current research was conducted.

Chandekar et al., (2018) recorded 71 butterfly species in Mulshi Tahsil, Pune District after conducting their research for a much longer time than that used in the current research while Dhakane and Wale documented 51 species from Ghodegaon, Ambegaon, Pune District over the span of 4 months. The maximum number was observed in November (129 specimens), and the maximum species richness was also seen in November, during which time all 44 species observed during the course of the study were recorded. This trend shows that post-monsoon season is an important phase in the activities of butterflies at Tungarli Lake. An earlier long-term study from Western Ghats by Naik *et al.*, (2022) [11] has shown that 49% of the specimens observed over the course of their two years of research occurred during the post-monsoon season from October to January, along with reporting a relationship between seasonal abundance and species richness.

Though the sample size was significantly larger and the landscape was different, the similar seasonal trend helps in the interpretation of the importance of the post-monsoon season in butterfly activities in Western Ghats landscapes. In terms of the composition of families, Papilionidae turned out to be the most diverse family, containing 11 species, while Pieridae and Nymphalidae contained 10 species each. Papilionidae also included the largest number of butterflies in the total collection (257 butterflies), followed by Nymphalidae (250) and Pieridae (245). This predominance of Papilionidae in terms of richness and abundance is unlike some other studies conducted in Maharashtra.

These results need to be interpreted considering the limitations of the current study. This study has described the seasonality in the abundance and community indices of butterflies but rainfall, temperature, relative humidity, vegetation coverage, flower density, larval host plant and habitat disturbances were not quantified during this study. Thus, all of these environmental variables cannot be stated statistically as factors affecting the seasonality in this community of butterflies. Instead, the present pattern can be considered as a seasonal baseline for further studies. Monitoring in long-term will help to know whether the peak of November abundance is constant throughout the years and how consistent is the diversity pattern.

Conclusion

The present investigation gives the annual baseline data of butterflies in terms of diversity and community composition at Tungarli Lake, Lonavala, Maharashtra. In total, 44 species belonging to five families and 952 specimens were noted. Family Papilionidae was the most species-rich and dominant among the families found in the study area. The maximum abundance and diversity of butterflies were recorded in the later phase of the observation period (November), whereas the Shannon-Wiener and Simpson's diversity indexes were also relatively higher in the late monsoon/post-monsoon phase.

The results clearly indicate the seasonal variations in the butterfly fauna and highlight the importance of the Tungarli lake landscape as a locally significant habitat supporting butterfly diversity. The conclusions are largely in agreement with the results obtained in the northern and central Western Ghats, including Maharashtra.

Because this study represents a single annual observation cycle, further multi-year and habitat-specific monitoring is recommended. Future studies incorporating vegetation structure, flowering and larval host-plant availability, climatic variables and anthropogenic disturbance would provide stronger evidence for explaining the mechanisms underlying seasonal changes in the butterfly community. The present study can consequently serve as a baseline against which future changes in butterfly richness, abundance and community structure at Tungarli Lake can be assessed.

References

1. Bonebrake TC, Ponisio LC, Boggs CL, Ehrlich PR. More than just indicators: A review of tropical butterfly ecology and conservation. Biological Conservation,2010:143(8):1831–1841. https://doi.org/10.1016/j.biocon.2010.04.044
2. Chandekar SK, Karkar HS, Nimbalkar RK, Mahajan DM. Study of butterfly diversity in Mulshi Tahsil, Pune District, Maharashtra, India. International Journal of Scientific Research in Science and Technology,2018:5(2):21–26.
3. Dhakane K, Wale R. Butterfly diversity in Ghodegaon area, Ambegaon, Pune, Maharashtra, India. International research journal of science and engineering,2020:A10:133-136.
4. Gay T, Kehimkar JD, Punetha JC. Common butterflies of India. Hyderabad: Oxford University Press, 1992.
5. Harsh. Butterfly Diversity of Indian Institute of Forest Management, Bhopal, Madhya Pradesh, India. Journal of Insects,2014:2014:254972.
6. Joshi R. Butterfly diversity of the ARAI Hills. Journal of Ecological Society,2021:32–33(1):50–56. DOI: 10.54081/JES.027/06.
7. Khyade VB, Jagtap SG. Butterflies- diversity in Mayureshwar Wildlife Sanctuary of Baramati Tehsil in Pune district, India. Journal of Entomology and Zoology Studies,2017:5(2):443–457.
8. Kunte KJ. Seasonal patterns in butterfly abundance and species diversity in four tropical habitats in northern Western Ghats. Journal of Biosciences,1997:22(5):593–603. https://doi.org/10.1007/BF02703397
9. Kunte K. India, a Lifescape: Butterflies of Peninsular India. Universities Press, 2000.
10. Kunte K, Joglekar A, Utkarsh G, Padmanabhan P. Patterns of butterfly, bird and tree diversity in the Western Ghats. Current Science,1999:77(4):577–586.
11. Naik D, Rao RSP, Kunte K, Mustak MS. Ecological monitoring and indicator taxa: Butterfly communities in heterogeneous landscapes of the Western Ghats and

Malabar coast, India. Journal of Insect Conservation, 2022. https://doi.org/10.1007/s10841-022-00368-5
12. Nimbalkar RK, Chandekar SK, Khunte SP. Butterfly diversity in relation to nectar food plants from Bhor Tahsil, Pune District, Maharashtra, India. Journal of Threatened Taxa,2011:3(4):1601–1609.
13. Padhye AD, Dahanukar N, Paingankar MS, Deshpande M, Deshpande D. Season and landscape wise distribution of butterflies in Tamhini, Northern Western Ghats, India. Zoo's Print Journal,2006:21(3):2175–2181.
14. Pielou EC. The measurement of diversity in different types of biological collections. Journal of Theoretical Biology,1966:13:131–144.
15. Shannon CE. A mathematical theory of communication. Bell System Technical Journal,1948:27:379–423, 623–656.
16. Varshney RK. Index Rhopalocera indica part II. Common names of butterflies from India and neighboring countries. Records of the Zoological Survey of India. Occasional paper No. 47, 1983, 1–49.
17. Wynter-Blyth MA. Butterflies of the Indian Region. Bom bay: Bombay Natural History Society, 1957. 523.