

Butterfly Species Diversity and Abundance in Relation to Environmental Factors Across Dry Deciduous, Open Scrub, and Urban Habitats of Durg and Rajnandgaon, Chhattisgarh, India

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Abstract

The diversity and abundance of butterflies in any landscape depend on a set of environmental factors that act at different scales, from regional climate to the microclimate of a forest floor or a city street. In Durg and Rajnandgaon districts of Chhattisgarh, three habitat types dominate the non-agricultural landscape: tropical dry deciduous forest on the western hills and plateau, open scrub on wasteland, degraded slopes and village commons, and the urban-industrial areas of Durg, Bhilai and Rajnandgaon. The present study analyses how butterfly species diversity and abundance are expected to vary across these three habitats in relation to temperature, humidity, rainfall, light and canopy cover, vegetation structure, host and nectar plants, soil moisture, elevation and human disturbance. The analysis is based on a systematic synthesis of field studies from comparable dry landscapes of central and peninsular India, the climatic and physiographic profile of the two districts, and established principles of butterfly ecology. A study from Bhopal in central India that compared the same three habitat types recorded 52 species in open scrub, 49 in dry deciduous habitat and 44 in urban habitat, with 47 species shared between scrub and forest. A study from a tropical dry forest in eastern India found that temperature, relative humidity and elevation increased species richness, while high light intensity and disturbance by fire, grazing and logging reduced it, and that riparian strips supported the highest abundance. On this evidence, open scrub is expected to hold the highest richness and abundance of sun-loving, grass- and herb-feeding species; dry deciduous forest to hold the most even communities and the largest number of shade-dependent and specialist species; and urban habitats to support fewer, more tolerant species, unless gardens and green spaces supply host and nectar plants. The study proposes an analytical framework for measuring environmental variables and relating them to butterfly assemblages, and it recommends habitat-specific management for the two districts.

Keywords: butterflies; species diversity; abundance; environmental factors; microclimate; dry deciduous forest; open scrub; urban habitat; Durg; Rajnandgaon; Chhattisgarh

1. Introduction

Butterflies are ectothermic insects whose activity, development and survival depend directly on the physical environment. Their larvae are usually restricted to a limited range of host plants, and their adults need nectar, water and suitable microclimates for flight and reproduction. As a result, the number of species and individuals present at a site reflects not only its vegetation but also its temperature, moisture, light regime and the degree of human disturbance. This close dependence on the environment makes butterflies valuable indicators for assessing habitat quality and the effects of land-use change (Thomas, 2005).

In tropical landscapes, the relationship between butterflies and their environment is shaped by strong seasonal contrasts and by the patchwork of habitats created by human use. Forests, scrub, farmland and settlements lie side by side, and each offers a different combination of shade, heat, moisture and resources.

Research in tropical regions has shown that butterfly communities respond sensitively to forest disturbance, microclimate and urbanisation, but the direction and strength of these responses vary between regions and habitat types (Bonebrake et al., 2010).

Durg and Rajnandgaon districts in the Chhattisgarh plain provide a clear example of such a mosaic. The western part of Rajnandgaon is hilly and forested, large areas of both districts carry open scrub on wasteland, hill slopes and village commons, and the Durg–Bhilai–Rajnandgaon corridor is one of the most urbanised and industrialised parts of the state. These three habitats differ sharply in their environmental conditions. Information on how butterfly diversity and abundance respond to these conditions in the two districts, however, is not yet available in a systematic form.

The present study addresses this need through an analytical synthesis. Its objectives are:

1. To describe the environmental characteristics of dry deciduous, open scrub and urban habitats in Durg and Rajnandgaon districts.
2. To analyse the expected patterns of butterfly species diversity and abundance across these three habitats, using evidence from comparable landscapes.
3. To examine the influence of individual environmental factors, including temperature, humidity, light, vegetation, water, elevation and disturbance, on butterfly assemblages.
4. To develop a framework for measuring environmental variables and relating them to butterfly diversity and abundance in future field studies.
5. To recommend habitat-specific management measures for butterfly conservation in the two districts.

2. Ecological Basis of Butterfly–Environment Relationships

2.1 Thermal ecology

Butterflies can fly only when their flight muscles reach a sufficient temperature. They regulate body temperature mainly through behaviour: basking with open wings in the sun, orienting the body towards or away from sunlight, perching on warm surfaces, and seeking shade when it is too hot (Clench, 1966). This dependence on temperature means that air temperature and solar radiation control daily and seasonal patterns of activity. At low temperatures butterflies cannot fly, and at very high temperatures they risk overheating and desiccation, so activity is greatest within an intermediate range.

2.2 Resource requirements

The presence of a butterfly species at a site depends on the presence of its larval host plants, adult nectar sources and, for many species, sources of water and minerals. At broad scales, the richness of butterfly species is closely related to the richness of plant species, because more plant species provide more potential hosts (Hawkins & Porter, 2003). Males of many species gather on damp soil, dung and other moist surfaces to take up sodium and other nutrients, a behaviour known as mud-puddling that links butterflies to water sources and riparian zones (Boggs & Dau, 2004).

2.3 Disturbance and land-use gradients

Human disturbance alters vegetation structure, microclimate and resource availability. Along an urban gradient in California, butterfly species richness and diversity were highest at moderately disturbed sites and lowest in the most developed areas (Blair & Launer, 1997). Across North America, butterfly diversity and abundance varied with the degree of habitat disturbance as well as with geography (Kocher & Williams, 2000). In tropical forests, selective logging changes the composition of butterfly communities, favouring species of open and edge habitats at the expense of shade-loving forest species (Hamer et al., 2003). These studies show that moderate disturbance can increase richness by creating open, flower-rich patches, while severe disturbance reduces it.

2.4 Microclimate

Conditions experienced by butterflies at ground level can differ greatly from regional climate. Canopy cover, vegetation height and the openness of the ground determine local temperature, humidity and light. Changes in land use and vegetation can therefore change the microclimate available to larvae and adults even where regional climate is stable; for example, denser vegetation growth can cool the microclimate of larval habitats and contribute to declines of warmth-requiring species (WallisDeVries & van Swaay, 2006).

3. Study Area and Habitat Types

3.1 Regional setting

Durg and Rajnandgaon lie in the upper Mahanadi basin, drained mainly by the Shivenath river and its tributaries. Durg district has a normal annual rainfall of about 1,142 mm, nearly 95 per cent of which falls from June to September, and temperatures range from about 8 °C in winter to about 46 °C in May and June (J. R. Verma, 2013). Rajnandgaon district receives a somewhat higher normal annual rainfall of about 1,252 mm, with temperatures from about 10 °C to 46 °C; its western part is hilly, its southern part forms a plateau and its eastern part a plain, and before the reorganisation of 2022 forests covered about 2,907 km² of its 8,172 km² geographical area (S. K. Verma, 2013). Soils include red lateritic and red loamy soils on uplands and black clay soils locally known as *kanhar* in the plains (S. K. Verma, 2013).

3.2 Dry deciduous forest

Tropical dry deciduous forest is the natural vegetation of most of central India (Champion & Seth, 1968). In the study area it occurs mainly on the western hills and plateau of Rajnandgaon and on scattered hillocks elsewhere. Trees such as teak, *Terminalia*, *Diospyros*, *Lagerstroemia*, *Butea* and bamboo form a canopy that is dense in the monsoon but largely leafless in the hot season. The forest floor is shaded and relatively humid during and after the rains, and nullahs and streams provide water and moist soil.

3.3 Open scrub

Open scrub consists of low thorny shrubs, scattered trees and grasses on degraded hill slopes, rocky outcrops, wasteland, fallow land and village grazing commons. Typical plants include *Lantana camara*, *Zizyphus*, *Acacia*, *Calotropis*, *Cassia* species, and a large variety of herbs and grasses that grow and flower after the monsoon. Scrub receives full sunlight, heats up quickly and dries out early, but in the monsoon and post-monsoon seasons it offers a dense supply of herbaceous host plants and flowers.

3.4 Urban habitat

The urban habitat includes the built-up areas of Durg, Bhilai and Rajnandgaon, together with industrial zones, roads and residential colonies. Vegetation is limited to roadside trees, parks, private gardens, institutional campuses and vacant plots. Paved surfaces raise temperatures and reduce humidity, artificial lighting extends into the night, and air pollution and regular removal of weeds reduce the availability of host plants. At the same time, planted ornamentals and watered gardens can provide nectar and moisture throughout the year.

Table 1 compares the main environmental attributes of the three habitats as they are expected to occur in the study area.

Table 1. Expected environmental profile of the three habitat types in Durg and Rajnandgaon

Attribute	Dry deciduous forest	Open scrub	Urban habitat
Canopy cover	High in monsoon, low in summer	Low; scattered shrubs and trees	Low to moderate; planted trees
Light at ground level	Shaded to partly sunny	Full sun	Sunny with patches of shade
Daytime temperature	Moderate, buffered by canopy	High, large daily range	Highest; heat retained by paved surfaces
Relative humidity	Higher, especially near streams	Low outside the monsoon	Low, except in watered gardens
Host plant diversity	High; trees, climbers, bamboo, herbs	High in herbs and grasses after rains	Low; mainly cultivated and weedy plants
Nectar sources	Seasonal flowering of trees and herbs	Abundant herb flowering after monsoon	Ornamentals, available year-round
Water and moist soil	Nullahs, streams, seepage	Scarce; seasonal pools	Drains, gardens, leaking pipes
Main disturbances	Fire, grazing, fuelwood cutting	Grazing, burning, clearing, encroachment	Construction, pollution, weed removal, traffic, artificial light

4. Methodology

The study is analytical and is based on a systematic synthesis of secondary sources. Peer-reviewed field studies from dry landscapes of central and peninsular India that reported butterfly diversity or abundance by habitat, or measured environmental variables, were identified and compared. Climatic and physiographic information for the two districts was taken from official reports of the Central Ground Water Board. The evidence was interpreted using ecological principles of thermal ecology, resource use and disturbance, and an analytical framework was developed for future field measurement. This framework comprises three components.

4.1 Measurement of butterfly assemblages

Butterflies should be counted along fixed transects of equal length in each habitat, walked at a constant pace in suitable weather, with all individuals recorded within a fixed distance of the observer (Pollard, 1977). The resulting data allow the calculation of the following measures. The relative abundance of each species is:

$$RA_i (\%) = (n_i / N) \times 100 \quad (1)$$

where n_i is the number of individuals of the i th species and N is the total number of individuals in the habitat. Species richness adjusted for sample size is given by the Margalef index (Margalef, 1958):

$$D_{Mg} = (S - 1) / \ln N \quad (2)$$

where S is the number of species. Diversity that accounts for both richness and evenness is measured by the Shannon–Wiener index (Shannon, 1948):

$$H' = - \sum p_i \ln p_i \quad (3)$$

where $p_i = n_i/N$. Dominance of the most abundant species is measured by the Berger–Parker index (Berger & Parker, 1970):

$$d = N_{\max} / N \quad (4)$$

where $N_{\max}$ is the number of individuals of the most abundant species. Similarity of species composition between two habitats is measured by the Jaccard index (Jaccard, 1912):

$$J = c / (a + b - c) \quad (5)$$

where a and b are the numbers of species in the two habitats and c is the number of species common to both.

4.2 Measurement of environmental variables

At each transect, the following variables should be recorded at the time of each count:

- **Air temperature and relative humidity**, using a digital thermo-hygrometer at about one metre above the ground.
- **Light intensity**, using a lux meter in the open and under the canopy.
- **Canopy cover**, using a spherical densiometer or hemispherical photographs.
- **Wind speed and cloud cover**, recorded on a simple scale.
- **Vegetation structure**, including the cover of trees, shrubs, herbs and grasses in fixed plots.
- **Host and nectar plants**, recorded as the number of flowering plant species and the presence of known host plants.
- **Water and moist soil**, noted as presence and distance to the nearest water source.
- **Elevation**, taken from a global positioning system receiver.
- **Disturbance**, scored for signs of fire, grazing, cutting, construction, waste dumping and traffic.

4.3 Statistical analysis

Relationships between butterfly measures and environmental variables should be tested with Spearman rank correlation for single variables, and with generalised linear or mixed-effects models that include habitat and season as factors. The combined influence of several variables on species composition can be analysed with canonical correspondence analysis (ter Braak, 1986), and species characteristic of each habitat can be identified with indicator species analysis (Dufrêne & Legendre, 1997). Because richness depends on sampling effort, comparisons should be based on rarefied or extrapolated richness (Gotelli & Colwell, 2001).

5. Diversity and Abundance Across the Three Habitats

5.1 Evidence from a comparable central Indian landscape

The closest available comparison comes from the campus of the Indian Institute of Forest Management at Bhopal, which lies in the same central Indian dry deciduous zone and contains the same three habitat types. That study recorded 55 species and 815 individuals of butterflies (Harsh, 2014). The habitat-wise results are shown in Table 2.

Table 2. Butterfly species richness in three habitat types at Bhopal, central India

Habitat type	Number of species	Main characteristic reported
Open scrub	52	Highest number of species and individuals; highest Shannon diversity ($H' = 3.76$)
Dry deciduous	49	Highest evenness
Urbanised	44	Lowest number of species
Shared between open scrub and dry deciduous	47	High similarity between the two natural habitats

Source: Harsh (2014).

Three features of these results are relevant to Durg and Rajnandgaon. First, open scrub supported slightly more species and clearly more individuals than forest. Second, forest had the most even community, meaning that individuals were spread more evenly among species rather than concentrated in a few common ones. Third, the urbanised habitat still supported 44 of the 55 species, which shows that urban green areas with suitable vegetation can retain a large part of the regional fauna. The most abundant species at Bhopal

were the Small Grass Yellow (*Eurema brigitta*), Common Grass Yellow (*Eurema hecabe*) and Lemon Pansy (*Junonia lemonias*), all species of open, sunny vegetation (Harsh, 2014).

A study in the tropical dry forests of the Eastern Ghats in Odisha provides a further comparison within forest landscapes. It recorded 79 species and 1,614 individuals, with the most species in open forest (58), followed by riparian forest (56) and dense forest (46); mean abundance per transect, however, was highest in riparian forest (57.6), followed by dense forest (48.4) and open forest (41.2) (Mahata et al., 2023). Openness thus favoured richness, while moisture and shade near streams favoured abundance.

5.2 Dry deciduous forest

Dry deciduous forest in Rajnandgaon is expected to support the largest number of habitat-specialist species and the most even communities. Its butterfly fauna includes species that depend on forest trees, climbers and bamboo as larval hosts and on shaded, humid conditions as adults. Typical members of this group in central India include the Common Baron (*Euthalia aconthea*), Common Sailer (*Neptis hylas*), Commander (*Moduza procris*), Common Castor (*Ariadne merione*), Common Evening Brown (*Melanitis leda*), rajahs and nawabs (*Charaxes* species) and many skippers and forest Lycaenidae (Kunte, 2000). Forest edges and gaps add sun-loving species, so that richness is greatest where forest and open patches meet. In the dry season, when the canopy is leafless, abundance in forest is expected to fall sharply except near streams and seepages.

5.3 Open scrub

Open scrub is expected to show the highest abundance and, in the monsoon and post-monsoon months, among the highest richness of the three habitats. The dense growth of herbs and grasses after the rains provides host plants for many Pieridae, Lycaenidae and Nymphalidae, while the sunny conditions favour rapid larval development and adult activity. Typical species include the Plain Tiger (*Danaus chrysippus*), pansies (*Junonia* species), grass yellows (*Eurema* species), the Common Gull (*Cepora nerissa*), the Pioneer (*Belenois aurota*), the arabs and tips of the genus *Colotis*, and small grass blues (Kunte, 2000). Scrub communities, however, are dominated by a few very common species and fluctuate strongly between seasons, so their evenness is lower and their Berger–Parker dominance higher than in forest.

5.4 Urban habitat

Urban habitats are expected to have the lowest richness, with a community made up mainly of generalist species whose host plants are cultivated or weedy. Urbanisation reduces butterfly richness in most regions, although many species persist where green spaces are available (Ramírez-Restrepo & MacGregor-Fors, 2017). On a university campus in Nagpur, close to the study area, butterfly diversity declined along a gradient of increasing human impact (Tiple et al., 2007). Typical urban species in central India include the Common Mormon (*Papilio polytes*) and Lime Butterfly (*Papilio demoleus*) on citrus and curry-leaf trees, the Plains Cupid (*Luthrodes pandava*) on ornamental cycads, the Common Jezebel (*Delias eucharis*) on mistletoes of garden trees, the emigrants (*Catopsilia* species) on *Cassia* trees, and the Common Crow (*Euploea core*) on oleander and fig (Kunte, 2000). Parks, campuses and gardens with native host and nectar plants can raise urban richness substantially, as shown in tropical cities where parks supported a considerable share of the regional butterfly fauna (Koh & Sodhi, 2004).

6. Influence of Environmental Factors

6.1 Combined evidence

The study in the Eastern Ghats measured several environmental variables together and estimated their effects on butterfly species richness with structural equation modelling. Table 3 summarises the reported effects.

Table 3. Effects of environmental variables on butterfly species richness in a tropical dry forest

Environmental variable	Direction of effect	Approximate effect (%)
Temperature	Positive	+40
Relative humidity	Positive	+22
Elevation	Positive	+16
Light intensity	Negative	-14
Disturbance (fire, grazing, logging)	Negative	-14

Source: Mahata et al. (2023).

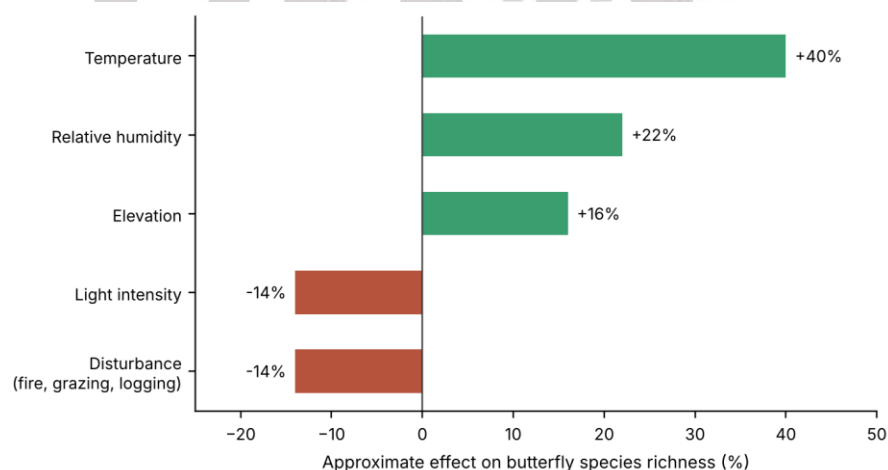


Figure 1. Effects of environmental variables on butterfly species richness in a tropical dry forest (data from Table 3)

Temperature emerged as the strongest positive influence, followed by humidity and elevation, while high light intensity and disturbance reduced richness. Canopy cover had no significant direct effect but acted indirectly through its influence on temperature, and a model based on microclimate explained the data much better than a model based on disturbance alone (Mahata et al., 2023). These findings come from the dry season, when heat and dryness are most limiting, and they are directly relevant to the dry deciduous forests and scrub of Rajnandgaon. The role of each factor in the three habitats of the study area is examined below.

6.2 Temperature

Temperature acts in two directions. Within the normal range, warmer conditions increase flight activity and allow more species to be active, which explains the positive effect on richness. Beyond about 40 °C, which is common in the study area in May and June, heat stress and desiccation reduce activity and survival. In open scrub and urban habitats, ground and surface temperatures in summer are much higher than air temperature, so butterflies confine their activity to the early morning and late afternoon. Forest canopy and riparian vegetation buffer these extremes, which is why shaded and moist habitats support more butterflies in the hot season.

6.3 Relative humidity and rainfall

Humidity reduces water loss from both larvae and adults and supports the growth of host plants. In the study area, humidity is high from July to October and very low in April and May. Rainfall controls the flush of herbaceous vegetation and therefore the timing of butterfly emergence; in the tropical dry forests of the Aravalli hills, season was the strongest predictor of both richness and abundance, and diversity was significantly higher in the monsoon than in winter and summer (Koli et al., 2025). Forest habitats retain humidity longer after the rains than scrub and urban areas, extending the period of high butterfly activity.

6.4 Light and canopy cover

Light intensity determines how quickly butterflies can warm up and how hot they become. Moderate light at forest edges and in gaps allows basking without overheating, while full sunlight on open ground in summer becomes excessive. Canopy cover influences butterflies mainly through its effect on light and temperature. Different species have different preferences: shade-loving browns and many forest nymphalids avoid open ground, while whites, yellows, tigers and many blues prefer full sun. A mosaic of canopy and open patches therefore supports the greatest variety of species.

6.5 Vegetation, host plants and nectar plants

The diversity of plants is one of the most important determinants of butterfly diversity, since most butterfly larvae feed on a limited range of host plants (Hawkins & Porter, 2003). Forests offer the greatest variety of trees, shrubs and climbers; scrub offers a great variety of herbs, legumes and grasses in the wet season; and urban areas offer mainly a few cultivated species. The availability of nectar plants affects adult abundance and longevity. Invasive plants such as *Lantana camara* are widespread in the scrub and forest edges of the study area; they provide abundant nectar to adult butterflies but displace native host plants on which larvae depend.

6.6 Water and soil moisture

Streams, nullahs, seepages and the margins of tanks provide moisture and minerals for mud-puddling and maintain green vegetation into the dry season (Boggs & Dau, 2004). In the Eastern Ghats, riparian forest had the highest abundance of butterflies and was regarded as the most preferred microhabitat because of its lower daytime temperatures (Mahata et al., 2023). In Durg and Rajnandgaon, the Shivnath and its tributaries, and the streams of the western hills, are therefore likely to be key sites for butterflies in all three habitat types, and urban drains and gardens may serve a similar role in towns.

6.7 Elevation and topography

Elevation in the study area ranges from the low plains of Durg to the higher hills of western Rajnandgaon. Higher ground is generally cooler, more humid and more forested, and it has escaped some of the clearing that has affected the plains. Slopes, valleys and ridges also create a variety of microclimates within a small area. These factors are likely to make the hill forests of Rajnandgaon the richest part of the study area for butterflies, consistent with the positive effect of elevation reported from dry forests (Mahata et al., 2023).

6.8 Human disturbance

Disturbance affects each habitat differently. In forests, fire, grazing and fuelwood cutting reduce the understorey and host plants and change the microclimate. Moderate opening of the canopy may increase richness by allowing sun-loving species to enter, but continued degradation removes the shade-dependent species that make forest communities distinctive. In scrub, repeated burning, overgrazing and clearing for construction or plantation reduce the herbaceous vegetation on which most scrub species depend. In urban areas, construction, paving, removal of weeds, pesticide spraying, air pollution, vehicle traffic and artificial lighting reduce both resources and survival.

7. Factor–Habitat Interactions

The evidence reviewed above suggests that the influence of each environmental factor depends on the habitat in which it operates. The main interactions can be stated as follows:

1. **Temperature has opposite effects in different habitats.** In shaded forest, higher temperature increases butterfly activity and richness; in open scrub and urban habitats during summer, further warming reduces activity.
2. **Humidity and water are most limiting in open and urban habitats.** Small sources of water and moist soil therefore have a much larger effect on abundance in scrub and towns than in forest.

3. **Plant diversity is the main constraint in urban habitats.** Urban butterfly richness depends more on the presence of suitable host and nectar plants than on climate.
4. **Disturbance has non-linear effects.** Moderate disturbance at forest edges may increase richness, while severe disturbance reduces richness in all three habitats (Blair & Launer, 1997).
5. **Season modifies all other factors.** Differences between habitats are expected to be smallest in the post-monsoon months, when resources are abundant everywhere, and greatest in summer, when only forest, riparian and watered areas support active butterflies.

These interactions explain why open scrub can show the highest richness and abundance in annual totals, as at Bhopal, while forest remains essential for specialist species and for survival during the hot, dry months.

8. Management Implications

8.1 Dry deciduous forest

- Control forest fires and regulate grazing and fuelwood collection, particularly in the dry season.
- Protect streams, nullahs and seepages, and maintain riparian vegetation as dry-season refuges.
- Retain forest gaps and edges with native flowering plants while preventing further fragmentation.
- Remove invasive *Lantana* gradually and replace it with native host and nectar plants.

8.2 Open scrub

- Recognise scrub and grassland as valuable habitats in land-use planning instead of treating them as wasteland.
- Prevent repeated burning and overgrazing, and allow herbs and grasses to complete their growth after the monsoon.
- Avoid converting scrub to monoculture plantations, which have lower host plant diversity.
- Create small water points or protect seasonal pools to support butterflies in the dry season.

8.3 Urban habitat

- Plant native host plants such as citrus, curry-leaf, *Cassia*, *Calotropis*, *Aristolochia* and native grasses in parks, campuses and industrial townships.
- Provide continuous flowering nectar plants through the year and leave some areas of unmown vegetation.
- Reduce pesticide spraying in public gardens and roadside plantations.
- Develop butterfly gardens in schools, colleges and the townships of the Durg–Bhilai industrial area, and link green spaces through tree-lined corridors.
- Reduce unnecessary artificial lighting near green spaces.

9. Limitations and Future Research

The study is based on secondary evidence from landscapes comparable to Durg and Rajnandgaon rather than on direct measurements from the two districts. The comparative studies differ in design, season and duration, and the effects of environmental variables were estimated in one forest landscape during the dry season only. The expected patterns described here should therefore be treated as hypotheses. Future research should:

- conduct year-round transect counts in all three habitats in both districts, with environmental variables measured at each count;
- quantify the microclimate of forest, scrub and urban sites using data loggers;
- map host and nectar plants and link them to the occurrence of butterfly species;
- measure the effects of fire, grazing, pesticide use, urban heat and artificial light on butterfly abundance; and

- establish long-term monitoring sites to detect trends and the effects of climate change.

10. Conclusion

The present study has analysed the relationship between butterfly species diversity and abundance and environmental factors across dry deciduous, open scrub and urban habitats of Durg and Rajnandgaon districts. The evidence from comparable central and peninsular Indian landscapes indicates that open scrub is likely to support the highest richness and abundance of sun-loving species, dry deciduous forest the most even communities and the greatest number of specialist and shade-dependent species, and urban areas the fewest species, dominated by tolerant generalists. Among environmental factors, temperature, humidity and elevation tend to increase richness, while excessive light and human disturbance reduce it; water sources, plant diversity and canopy structure determine where butterflies can persist through the hot season. The influence of each factor depends on habitat and season, so no single habitat can sustain the full butterfly fauna of the region. Conservation in the two districts therefore requires protecting the hill forests and their streams, valuing and managing open scrub, and making urban areas more hospitable through native planting and reduced disturbance, supported by field studies that measure butterflies and their environment together.

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