

1 **COMMUNITY COMPOSITION AND DYNAMICS OF BUTTERFLIES IN DIFFERENT**
2 **MICROHABITATS OF CENTRAL ARAVALLI HILL REGIONS OF AJMER**
3 **DISTRICT, RAJASTHAN, INDIA**

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7 **ABSTRACT**
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Aims: Butterflies are the symbol and target species for conservation in many parts of the world, and are key indicators of an environment's ecological status. The abundance, brief generation time, quick movement, and sensitivity to climatic changes of the butterfly fauna make it a significant predictor. It is crucial for effective and suitable butterfly protection to conduct research on biodiversity, ecology, and habitat suitability.

Place and Duration of Study: The study was conducted in Ajmer City, Rajasthan, India. The four sites for butterfly collection were Open Land, Scrub Land, Aravalli Hills, and MDS University Campus to reflect the variety of environments in Ajmer. Scrub land makes up 1.5 km², open ground 1.3 km², the MDS University campus 0.5 km², and the Aravalli hills 2 km² of the 5.3 km² research regions.

Methodology: For butterfly studies, the Pollard walk technique was used, with 20 fixed transects placed stratified and randomly across four environments. Adult butterfly individuals were noted while walking at a slow, steady speed within a assumptive 5 m radius and Alpha and Beta diversity analysis was performed using PAST 4.06 and Microsoft Excel 2010

Results: During the study, 54 butterfly species from five groups were identified. The most diverse families were Nymphalidae and Pieridae, then Lycaenidae, Hesperidae, Papilionidae.

Conclusion: It is essential to track changes in the butterfly population as an indicator for climate and human impacts because they are sensitive to changes in their surroundings, they perform functions like pollinating various plant species. However, by planting appropriate trees, plants, and other vegetation that will support the organisms' continued health, we can at least try to lessen them. At a minimum, this attempt will prevent the common species from facing extinction.

9
10 *Keywords:* Butterfly, Community Composition, Microhabitat, Rajasthan, Conservation.
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13 **1. INTRODUCTION**
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15 Ecosystems and habitats are always transforming, and some of these alterations are fueled by
16 human influences. As a result, continuous ecological monitoring is required to assess the status
17 of the ecosystem and biodiversity (Lindenmayer and Likens, 2018). We study biological
18 indicators to better understand the role of biodiversity in management of ecosystems (Maleque *et*
19 *al.*, 2009). The human development process is one of several elements proven to have an impact
20 on biodiversity in many regions. Construction operations such as road construction, power
21 transmission line construction, energy development, and waterway excavation and impoundment

22 for development have been shown to have an impact on land cover and on variety of species
23 including butterflies (Gasparatoset *al.*, 2017).

24 Butterflies are a flagship and target species for conservation in many parts of the world,
25 particularly for invertebrates (New, 2011). Butterflies are simple to examine because of their
26 fairly large size and distinctiveness, as well as their well-known taxonomy (Brown, 1991). They
27 are a key component of biodiversity in natural environments due to their strong complicated
28 linkages in the food web (Bonebrake *et al.*, 2010). The adult forms consume nectar and pollinate,
29 which is essential for the ecological functioning (Tiple *et al.*, 2006), and larval forms serve as
30 primary consumers and prey to species at higher trophic levels. Therefore, butterflies provide
31 dual functions as pollinators and energy transferors. Butterflies are key indicators of an
32 environment's ecological status and biotope quality (Launer and Murphy, 1994; Sharma *et al.*,
33 2020), as prospective pollinators of their nectar plants and indicators of the health and quality of
34 their host plants and the ecosystem as a whole. The butterfly fauna is an important indicator
35 because it is abundant, its generation is short, its migration is fast, and it is very sensitive to
36 environmental changes (Lee and Kwon, 2014).

37 Many species are habitat specific and are extremely vulnerable to habitat degradation, which
38 includes changes in microclimate, vegetation structure, and the co-occurrence of plant types on a
39 local scale (Bonebrake *et al.*, 2010; Sharma *et al.*, 2020). Seasonal factors, in addition to habitat
40 types, play an important role in defining the spatiotemporal patterns of butterfly species richness
41 and diversity (Kunte, 1997; Sengupta *et al.*, 2014; Sharmila *et al.*, 2020). Temperature and
42 rainfall patterns impact the similarity and variety of local butterfly populations (Grøtan *et al.*,
43 2012, 2014)

44 Butterflies are extremely sensitive to fractional fluctuation in climatic conditions and disturbance
45 in their habitats due to their short life spans, host plant specialization, and limited dispersion
46 capabilities in majority of species (Kocher and Williams, 2000). The undisturbed natural flora
47 and seasonal flowering plantation provide promising habitat for butterfly populations if there are
48 no development operations or contamination from industrial hazardous waste (Tiple, 2012).

49 In this context, studies on diversity, ecology, and habitat appropriateness are critical for
50 successful and proper butterfly conservation (Sharma *et al.*, 2020). Studies are vital for
51 understanding butterfly diversity, ecology, and numerous functions in an ecosystem, as well as
52 for investigating the influence of disturbance and land use changes on them (Bhardwaj *et*

53 *al.*,2012). All of these characteristics make them a viable model for ecological and conservation
54 research, emphasizing the importance of establishing good conservation approaches (Ehrlich and
55 Hanski, 2004). As an outcome of our current work, an inventory of butterfly faunal diversity and
56 abundance is developed.

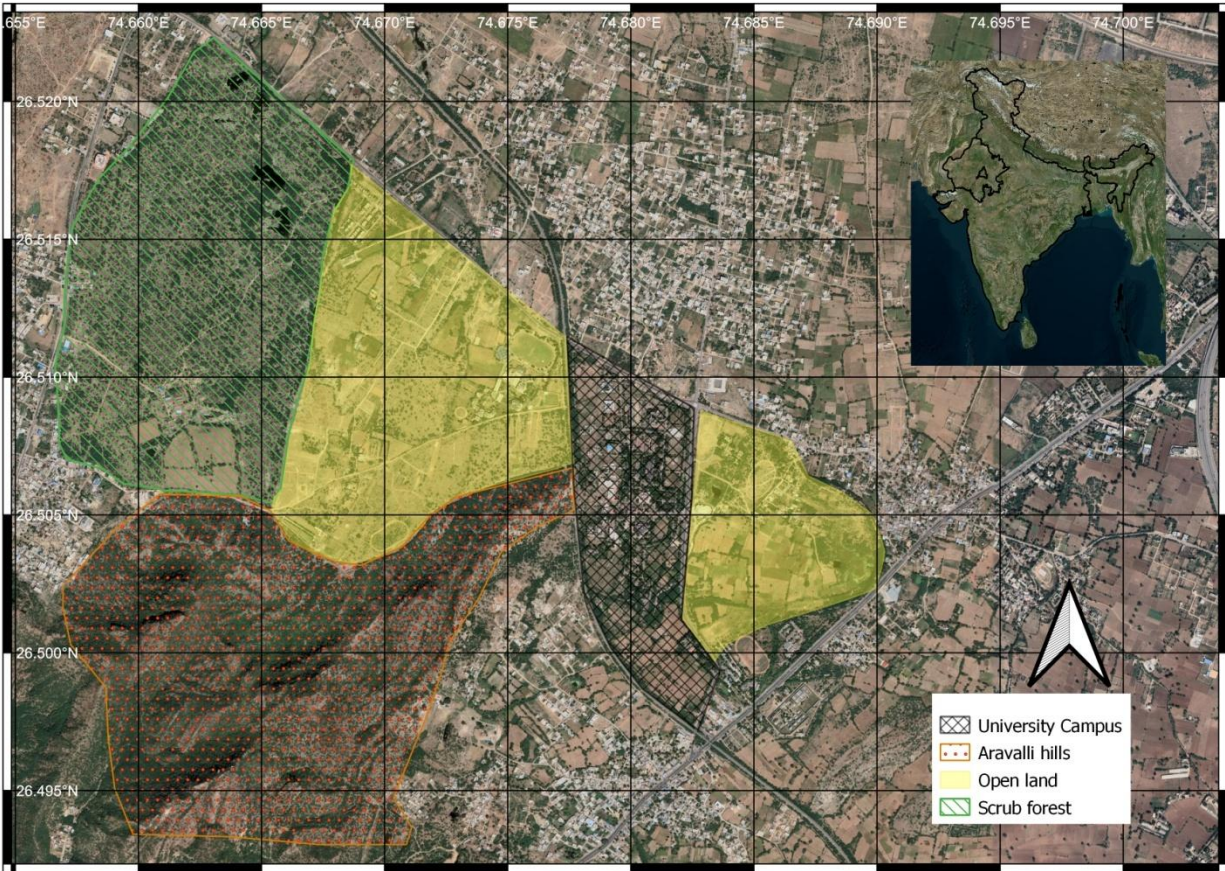
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2. MATERIAL AND METHODS

2.1 Study Area

62 All of the investigation locations were in the Central Aravalli Hill Ranges of Ajmer City,
63 Rajasthan, India. Ajmer has semi-arid climate with bushy and thorny vegetation (Singh *et al.*,
64 2022). The average annual rainfall in Ajmer is 525 mm, with 90% of it falling between June and
65 September, while the average yearly temperature is 30-40°C. Four microhabitats for butterfly
66 sampling were chosen to represent the diverse landscapes of Ajmer. The four ecologically
67 diverse study landscapes were Open Land, Scrub Land which also includes some water bodies,
68 Aravalli Hills, and MDS University Campus, which were located between the latitude and
69 longitude of 26.50°N and 74.68°E.

70 Open Lands include areas near university with scattered vegetations which are chiefly grasses
71 and herbs. Scrub Lands were dominated by dense scrubs and trees like *Prosopisjuliflora*,
72 *Calotropisprocera*, *Prosopis cineraria*, *Lantana camara*, *Capparis decidua* and *Acacia senegal*.
73 The rocky terrain of Aravalli Hill regions encompassing the regions of ancient central aravallies
74 in Rajasthan, the chief vegetations are *Acacia arabica*, *Prosopisjuliflora*, *Cynodondactylon*etc.
75 MDS University Campus is area with highest human activities among all and is most diverse in
76 terms of both natural and ornamental flora that include *Azadirachtaindica*, *Alstoniamacrophylla*,
77 *Acacia acacia*, *Calotropis gigantean*, *Ziziphusnummularia*, *Adhatodavasica*, *Bougainvillea sp.*
78 and invasive flora such as *Prosopisjuliflora*, *Lantana sp.* and *Parthenium sp.* The total study area
79 is 5.3 km² approximately, in which scrub land accounts for 1.5 km², open land for 1.3 km², MDS
80 University campus for 0.5 km², and Aravalli Hills for 2 km².



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82 Figure 1. Four studied microhabitats in study area located at Ajmer district, Rajasthan India.

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84 **2.2 Data Collection and Analysis**

85 Sampling was carried out for a period of one year between November 2021 and October 2022.

86 Pollard walk method was used for butterfly surveys (Pollard 1977). At each site, a road transect
 87 method was followed to collect the data. Each site was visited twice a month (N=96) and on each
 88 day sampling was carried out for 3 hours in morning (07:00 to 10:00 hrs) and 3 hours in evening
 89 (16:00 to 19:00 hrs).

90 The study area was explored during three seasons: summer (March-June), monsoon (July-
 91 October) and winter (November-February). Twenty permanent transects (N = 20), each of 300m
 92 in length were laid in a stratified and random manner across four habitats (N = 5 each) in the
 93 study area. The consecutive transects in a habitat were spaced 50m apart from each other.
 94 Individuals of adult butterflies were recorded and counted around an imaginary 5m radius while
 95 walking with a slow, constant pace in each permanent transect. Ten transects (N = 10) were
 96 covered in each sampling day, mostly during cloudless and sunny weather conditions in order to
 97 spot maximum butterflies (Subedi *et al.*, 2020).

98 The identification of butterflies was done in the field based on morphological and behavioral
 99 descriptions with reference to Kehimkar (2016) followed by photography using DSLR Canon-
 100 EOS 1300D and Nikon D5300 (55-300mm).

101 Alpha and beta diversity were calculated using the following indices: Shannon Weiner Index,
 102 Simpson Index, Evenness Index, Berger Parker Index of Dominance, Margalef's Index for
 103 Richness, Whittaker's Beta Diversity was also compared pairwise for each of the four locations.
 104 Microsoft Excel 2010 and PAST 4.06 (Hammer *et al.*, 2001) were used for all statistical analysis.

105
 106 **3. RESULTS AND DISCUSSION**
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108 From the four study sites, 54 butterfly species from five families were identified over the course
 109 of the investigation (Table 1). With 16 species (29.6%), Nymphalidae had the highest species
 110 richness, followed by Pieridae (14 species, 25.9%), Lycaenidae (11 species, 20.3%), Hesperidae
 111 (7 species, 12.9%), and Papilionidae (6 species, 11.1%). Pairwise comparison of Whittaker's Beta
 112 Diversity index showed highest value of 0.36842 between University Campus and Aravalli Hills
 113 (Table 3). Two species of Lycaenidae, *Azanusuranus* and *Rapalajarbus* were found only in one
 114 study area that was University campus with mixed vegetation. One species of Hesperidae
 115 (*Suastusgremius*) was only found at open land with very low vegetation and one species of
 116 Nymphalidae (*Acraeaviolaei*) was only found at scrub forest dominated with scrubby
 117 vegetation. According to Table 2, there is more species richness species in scrub forest with water
 118 bodies than in open land with little vegetation followed by university campus with a variety of
 119 vegetation, and the Aravalli hills in that order. Alpha species diversity (α) is highest at university
 120 campuses with mixed vegetation have high Simpson (0.9637) and Shannon (3.556) indices
 121 values, while Aravalli Hills have the lowest diversity according to both indices (0.9084 and
 122 2.661). However, Aravalli Hills (0.09157) exhibits higher Dominance than other locations.

123 The highest Whittaker's Beta diversity is between the university campus and the Aravalli hills
 124 (0.36842), and the lowest is between the university campus and open land (0.039216) (Table 3).

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126 Table 1: Distribution of the different butterfly species observed at the four study sites.

S.No	Family	Scientific Name	Study sites and number of sightings			
			Aravalli Hills	Scrub Forest	University Campus	Open Land
1	Hesperidae	<i>Hasorachromus</i>	0	10	30	22
2		<i>Sarangesapurendra</i>	18	31	40	22

3		<i>Spialialgalba</i>	5	10	40	30
4		<i>Suastusgremius</i>	0	0	0	5
5		<i>Parnaraguttata</i>	0	20	30	23
6		<i>Borbocinnara</i>	0	0	20	11
7		<i>Pelopidas mathias</i>	12	20	31	11
8	Papilionidae	<i>Graphiumdoson</i>	0	2	3	2
9		<i>Graphiumaganemnon</i>	1	5	10	20
10		<i>Pachlioptaaristolochiae</i>	0	10	40	44
11		<i>Pachliopta hector</i>	0	10	40	33
12		<i>Papiliopolytes</i>	20	25	70	55
13		<i>Papiliodemoleus</i>	0	5	30	50
14	Pieridae	<i>Euremabrigitta</i>	0	22	30	27
15		<i>Euremahecabe</i>	5	30	44	32
16		<i>Euremalaeta</i>	0	12	30	20
17		<i>Catopsiliapomona</i>	7	29	40	33
18		<i>Catopsiliapyranthe</i>	0	32	70	60
19		<i>Colotisamata</i>	0	19	49	33
20		<i>Colotisetrida</i>	20	40	80	44
21		<i>Colotisfaustafausta</i>	2	20	30	13
22		<i>Ixias marianne</i>	0	20	33	14
23		<i>Ixias pyrene</i>	1	2	5	2
24		<i>Pieriscanidia</i>	0	2	12	8
25		<i>Ceporanerissa</i>	5	11	28	22
26		<i>Delias eucharis</i>	0	4	1	0
27		<i>Belenoisaurota</i>	0	10	55	33
28	Lycaenidae	<i>Catochrysopsstrabo</i>	1	40	55	22
29		<i>Leptotesplinius</i>	0	15	45	33
30		<i>Tarucusnara</i>	5	20	100	91
31		<i>Zizeeriakarsandra</i>	0	0	4	7
32		<i>Zizulahylax</i>	0	10	50	44
33		<i>Azanusuranus</i>	0	0	3	0
34		<i>Freyeriaputli</i>	2	20	66	29
35		<i>Freyeriatrochylus</i>	0	10	18	11
36		<i>Chiladespandava</i>	0	12	44	20
37		<i>Chiladesparrhassius</i>	11	66	90	70
38		<i>Rapalaiarbus</i>	0	0	10	0
39	Nymphalidae	<i>Trimalalimniace</i>	5	20	5	15
40		<i>Danausgenutia</i>	0	0	3	1
41		<i>Danauschrysippus</i>	50	59	130	40
42		<i>Euploea core</i>	0	3	5	11
43		<i>Melanitisleda</i>	0	0	1	1

44	<i>Melanitisphedima</i>	0	5	1	2
45	<i>Ypthimaasterope</i>	20	100	200	140
46	<i>Acraeaviolae</i>	0	1	0	0
47	<i>Phalantaphalanthia</i>	10	11	5	2
48	<i>Vanessa cardui</i>	50	43	30	37
49	<i>Junoniaorithya</i>	77	60	140	108
50	<i>Junoniahierta</i>	50	16	70	33
51	<i>Junoniaalmana</i>	30	28	120	100
52	<i>Junonialemonias</i>	23	33	56	43
53	<i>Hypolimniasbolina</i>	0	19	28	25
54	<i>Hypolimnasmisippus</i>	0	6	20	10

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128 Table 2: Alpha diversity indices of butterflies recorded at four study sites.

	Aravalli Hills	Scrub Forest	University Campus	Open Land
Total Sightings	430	998	2190	1564
Species Richness				
Species	24	47	52	50
Margalef's Richness	3.793	6.661	6.631	6.662
Evenness				
Pielou's Evenness Index	0.5965	0.7095	0.6738	0.6969
Dominance				
Dominance_D	0.09157	0.03873	0.03627	0.03673
Berger-Parker	0.1791	0.1002	0.09132	0.08951
Diversity				
Simpson_1-D	0.9084	0.9613	0.9637	0.9633
Shannon_H	2.661	3.507	3.556	3.551

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130 Table 3: Pairwise comparison of Whittaker's Beta Diversity of butterflies recorded in four study sites

	Aravalli Hills	Scrub Forest	University Campus	Open Land
Aravalli Hills	0	0.32394	0.36842	0.35135
Scrub Forest	0.32394	0	0.070707	0.072165
University Campus	0.36842	0.070707	0	0.039216
Open Land	0.35135	0.072165	0.039216	0

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132 Butterflies are an important part of the food chain **therefore**, they serve as markers of
 133 environmental changes in their surroundings. They have greater sensitivity than a lot of other
 134 biological groups (Thomas, 2005). Because of high availability of food plants, 24 species
 135 (44.4% of total), 3 of Hesperidae, 4 of Lycaenidae, 9 of Nymphalidae, 2 of Papilionidae and 6 of

136 Pieridae were noticed in all study sites, There are 9 species of Nymphalidae, 5 species of
137 Pieridae, 5 species of Lycaenidae, 3 species of Hesperidae, 2 species of Papilionidae that use
138 every study habitat, which suggests that they are strong, energetic flyers that may aid them in
139 looking for resources over wide regions (Eswaran and Pramod, 2005; Krishnakumar *et al.*,
140 2008).

141 Under Wild Life Protection Act, 1972 one species *Pachliopta hector* (Crimson rose) of
142 Papilionidae family is classified in Schedule-I. Two species *Hypolimnasmisippus*
143 (*Danaideggfly*) of family Nymphalidae and *Ceporanerissa* (Common gull) of Pieridae family in
144 Schedule-II and one species *Euploea core* (Common crow) of Nymphalidae in Schedule-IV are
145 valuable from conservation point of view.

146 147 **4. CONCLUSION** 148

149 From the study sites, a total of 54 species of butterflies have been documented. Among the five
150 recorded butterfly families in the four studied microhabitats, Nymphalidae appears to be the most
151 diverse not only in abundance but also in species richness (n=16, 29.6%), followed by Pieridae
152 (n=14, 25.9%), Lycaenidae (n=11, 20.3%), while families with lowest species richness are
153 Hesperidae (n=7, 12.9%) and Papilionidae (n=6, 11.1%). The diversity of Nymphalidae and
154 Pieridae is greater in terms of species abundance in the study area, according to our present
155 outcomes, which are followed by Lycaenidae. The two families Hesperidae and Papilionidae
156 showed the least diversity. The information gathered in this study's data could prove invaluable
157 as a resource for monitoring changes in butterfly populations, as an indicator for climate changes
158 in the area in the future. The depicted butterfly family and species list is not final and
159 comprehensive, so long-term research work with periodic surveys of the vegetation cover and
160 tracking of the diversity of butterflies may be performed in the study area with a focus on
161 ecological aspects. Due to their sensitivity to environmental changes they act as natural indicator
162 of disturbances in the ecosystems. Insects play an important role in the structure of a society by
163 providing services like pest control, nutrient depletion, and decomposition, as well as pollinating
164 different plant species. To protect them we can promote planting suitable vegetations like host
165 plants that will help the organisms stay healthy. By making such an attempt, at the very least, the
166 common species won't be on the verge of extinction.

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