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Suitability of Butterflies as Indicators of Ecosystem Condition: A Comparison of Butterfly Diversity across four habitats in Gir Wildlife Sanctuary

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Abstract

Gir forest of Gujarat is widely known as the last home of Asiatic Lion. It also hosts a range of other mammalian, avian, reptiles and insect species biodiversity. The sanctuary area has been explored in the present study for diversity and species richness of small but important creatures called butterflies. Butterflies have been depicted as significant indicator species owing to their sensitivity to slightest change in environmental factors. Their habitat signals a healthy ecosystem. Danaidae and Nymphalidae butterflies were observed the most abundant while Hesperiidae butterflies were recorded the least dominant. Butterfly diversity has been observed higher in thinned, thinned and burnt and in wildfire (disturbed forests) in comparison to the natural dense forests. It was observed that the population of butterflies were found more in the disturbed forests as they interact the most in disturbances; hence they are the ecological indicators of climate change.

Keywords: Gir forest, species richness, butterflies, disturbed forests, ecological indicators.

Introduction

Gir forest of Gujarat is a huge, diversified forest in terms of flora and fauna. Besides being famous for the majestic Asiatic Lion, several species dominate the area. Insects are one of them. Insects are important components of forest biodiversity, which are closely related to plants. Variation of insect diversity is of significance for assessing forest ecosystem health. Butterflies are one of the most charming and easily recognizable insects that belong to order Lepidoptera. They have a fairly clear taxonomy, and their life history and biology are well defined (Nelson and Anderson,1994; Wood and Gillman,1998).Their ability to adapt to virtually any climate, has made them some of the most successful creatures on earth.

Butterflies are considered important flagships for insect conservation (New *et al*., 1995; Smetacek, 1996). More attention is paid throughout the world, because of their important service in environmental quality assessment under terrestrial ecosystem (Ghazoul, 2002). They are considered to be one of the several insects that are a potential ecological indicator of forest condition. Indicator species are thought to either signal the presence /abundance of other species, or to signal chemical/physical changes in the environment through changes in their own presence or abundance (Landres *et al*.,1988; Simberloff,1998). The second of these types of indicators is referred to as an ecological indicator (McGeoch 1998). A number

of authors *viz.*, Landres *et al*.,1988; Rodriguez *et al*.,1998 and Ferris and Humphrey,1999 have proposed criteria for selecting indicator species. In many regions of the world, Lepidoptera are widely accepted as ecological indicators of ecosystem health (Rosenberg *et al*.,1986; New *et al*., 1995; Beccaloni and Gaston,1995; Oostermeijer and Van Swaay,1998), and meet a number of criteria set forth by Hilty and Merenlender (2000). Their behavioral aspects towards light, temperature, and habitat requirements have been quantitatively assessed (Warren,1985; Thomas and Harrison,1992; Oostermeijer and Swaay,1998; Pollard *et al*.,1998). Demonstration of their correlations with changes in ecosystem conditions has been done (Bowman *et al*.,1990; Thomas and Harrison,1992; Hill *et al*.,1995; Pullin,1996; Spitzer *et al*.,1997; Pollard *et al*.,1998; Swengel,1998). In addition, butterflies are small, have high reproductive rates, and are at a low trophic level that allow them to quickly respond to environmental stress. Many butterflies specialize on a specific plant species for oviposition or feeding (Ehrlich 1984, Oostermeijer and Van Swaay 1998). Butterflies tend to be easy to find and measure. Also, they are charismatic, and the public tends to show interest in them. Previously used or suggested indicator organisms include butterflies (Kremen, 1992, 1994; Launer and Murphy, 1994).

In the present study, a detailed research was carried out to document the butterfly species abundance, richness and diversity of Gir Wildlife Sanctuary of Gujarat in relation to habitat variations within Gir. An attempt has been therefore made to understand the causes in changes in butterfly biodiversity in respect to their habitat type and assess the suitability of using these small creatures as environmental indicators of Gir forest.

Materials and Methods

Study Area

The study area, Gir Wildlife Sanctuary (West) *i.e.* between Latitude 20 ^{o} 40' N to 21 ^{o} 50' N and Longitude 70 ^{o} 50' E to 71 ^{o} 15' E (Krishnan and Guha, 2006) encompassing 678.45 sq. km area was covered in a period of two years (2011 to 2013). The area was explored based on selected eight ranges (Dedakadi, Visavadar, Babaria, Chhodvadi, Devalia, Jamwala, Sasan and Ankolwadi).The major vegetation of the area consists of *Tectona grandis, Wrightia tinctoria, Acacia catechu, Zizyphus mauritiana, Acacia nilotica, Terminalia crenulata, Diospyros melanoxylon, Bauhinia purpurea, Grewia tiliaefolia, Boswellia serrata* and *Butea monosperma* (Sharma and Johnshingh, 1995).

Methodology

Since it was difficult to explore the whole of Gir in a short stretch of time (2011 to 2013) by systematic sampling methods, Random Sampling Method was used in which the Gir Wildlife Sanctuary (West) was divided into eight ranges (Kumar and Meena, 2012). Each range was explored on line transects based on possibility and availability of the species. All the natural and artificial water points and major reservoirs were checked. The species of butterflies were captured using aerial net with utmost care regarding their wings. After examination of the specimens, they were released back into the wild. All specimen were identified by using diagnostic keys by Haribal (1992), Bingham (1905), Evans(1932), Talbot(1939), Wynter-Blyth(1957), Kunte(1997 & 2000), Daccordi *et al*.(1988), Smart(1991), Antrum (2002) and Kehimkar (2008). In the field observations, specimens were photographed using a Nikon D 3100 Digital Camera with 14.2 megapixel DX format CMOS image sensor. The diversity pattern of butterfly communities has been studied in four habitat types in GNPS. A modification of the line transect count was used to determine species richness and abundance of butterfly families in four habitats. In each habitat, two sites have been chosen for the study. In all 8 sites a transect of 500 m each were setup. It took an hour time for survey in each transect. The transects were restricted to only patrolling paths in the GNPS. The four habitats including eight sites are Thinned, Thinned and burnt, Wildfire in forest and Natural dense forest (Unmanaged). All the butterflies on the line as well as 5 m on either side were recorded with time and number of individuals were seen between 7:00 h and 19:00 h when butterflies were basking, mud puddling and foraging. All the four habitats were selected as per the habitat classification given by Khan (1993). In GNPS the forest is of mixed type in all the four habitats.

Habitat 1: Thinned & Burnt forest (Rivarine woodland)

It is located in whole Gir with many water bodies (Reservoir, Rivers, ponds and lakes). A distinct belt of vegetation *viz. Syzygium cuminii, Pongamia pinnata, Ficus recemosa, F. benghalensis, Holoptilia integrifolia, Mitragyna parvifolia, Tamarindus indica, Sapindus emarginatus* and *Albizia lebbeck*. The under

storey vegetation is *Carissa congesta* . Post monsoon thinning of forest is the regular activity of this area.

Habitat 2 : Natural dense forest (Mixed Teak woodland)

It is located in the central Gir.The natural vegetation consists of *Tectona grandis, Acacia Senegal, T. crenulata, Boswellia serrata, Sterculia urens* and *Acacia catechu*. The under storey vegetation is *Carissa carandas, Wrightia tinctoria* and *Grewia tiliaefolia etc.* This is the unmanaged forest area of GNPS.

Habitat 3: Wildfire in Forest (Teak-Acacia Zizyphus woodland)

Teak bearing areas are mainly confined in the western part of Gir Forest. The natural vegetation consists of flat plains of thorn forest. The dominant species are *Tectona grandis, Acacia Senegal, Zizyphus mauritiana* and *Acacia nilotica*. The under storey vegetation is *Carissa congesta* . Wild fire is the occasional activity due to high temperature.

Habitat-4: Thinned Forest (Savanna)

It is located in whole Gir. The natural vegetation are annual and perennial Grasses. Shaniyar, Jinjavo and Ratad are the most dominant grass species. *Acacia* and *Zizyphus* sp. were the dominant tree species. From this area two sites had been selected and from each site one transect was setup. Cattle grazing were a frequent activity observed in this area.

Data analysis

Raw data from the field were used to reveal species richness, (Margalef's index of richness, Magurran, 1988), species diversity (Shannon-Weiner index, 1948), component of dominance (Simpson dominance index, 1949), species evenness (Pielou's evenness index, 1966) and relative abundance of different species in each sampling site. Jaccard's similarity coefficients (Jaccard, 1908) was measured and a dendrogram based on similarity coefficient generated by the Un-weight Pair Group method using arithmetic averages (UPGMA), (Sneath and Sokal, 1973) and Sequential Agglomerative Hierarchial Non-overlapping (SHAN) clustering. The statistical analysis was done by using the MS excel, SPSS ver.8.0 and NTSYS-PC ver.2.02i software (statistical analysis package). Significance of differences among means was compared at P≤0.05. The Kruskal-Wallis test was used to compare species composition between different habitat types.

Shannon-Weiner Index is the measurement of **species diversity** and it is denoted by H_s.

$$H_s = - \Sigma[Pi \log e Pi]$$

Simpson Index (Simpson, 1949) is the measurement of concentration of **dominance** (D_s) that ranges from 0 to 1. Where, 1 indicates the vegetation of single species and lower values indicating the sharing of dominance.

$$Ds = \frac{\sum n(n-1)}{N(N-1)}$$

Where, n = the total number of organisms of a particular species

N = the total number of organisms of all species

The **species richness** was calculated by using the method Margalef's index of richness (D_{mg}) as per Magurran (1988).

$$D_{mg} = (S-1)/ \ln N$$

Where, S = Total number of species
N = Total number of individuals

The measurement of **evenness** is denoted by e and it is obtained as per Pielou (1966):

$$e = H_s / \log 10 S$$

Where, S = Total number of species

Results

Butterfly sampling

A preliminary survey was conducted in Gir Wildlife Sanctuary to get well acquainted with the butterfly species present here for a period of 6-8 months. The procedure of observation was the focus and identification of butterflies was done by field guides. The list of identified butterflies has been illustrated in table 6. The seasonal fluctuation was observed in the population of butterflies.

Diversity pattern of lepidopteron fauna in different habitat types in GNPS

The experiments had been conducted in four selected habitats *viz.*, Thinned, Thinned & burnt, wildfire in forest and dense natural forest (unmanaged). All the four habitats differ in their habitat features, vegetation, presence of water points and disturbances. Butterfly diversity has been observed higher in thinned, thinned and burnt and in wildfire (disturbed forests) in comparison to the natural dense forests. It was observed that the population of butterflies are found more in the disturbed forests as they interact the most in disturbances; hence that they are the ecological indicators of climate change. The dry vegetation and less water results in less butterfly populations. The abundance and richness of the butterflies increased with decreasing temperature and increasing humidity. Four habitats within GNPS were evaluated for analysis of the association of the butterfly species with the habitat. A total of 1000 individuals representing 53 species were observed across the four habitat types. Out of these, members belonging to the family Pieridae were the most common with 16 species being recorded accounting for 30% of total 53 species. The maximum diversity and abundance was observed in the thinned forest and thinned & burnt areas; these two habitats shared 24 species. The butterflies *viz. Danais chrysippus, Junonia hierta, Junonia orithya, Euploea core, Ypthima asterope, Tarucus nara, Papilio demoleus, Pachliopta aristolochiae* and *Catopsilia* species, etc. preferred thinned and thinned & burnt forest habitats than the natural dense forest habitat. The species profile of butterfly communities associated with different habitats has been shown (Table-1; Fig. 1 & 2). Eight sites were selected from all the eight ranges. All the sites come under four habitat types. They are **Habitat-1**, Thinned and burned Forest ; Site-1 Dedakadi, Site-2 Jaradaa Vistaar , Site-3 Raidi; **Habitat- 2** Natural dense or unmanaged Forest; Site-4 Chhodvadi , Site-5 Devadunger, Site-6 Hadala; **Habitat- 3**: wildfire in Forest; Site-7 Kapuria ; **Habitat- 4**: Thinned Forest; Site-8 Chodiya vistaar. The interaction of host-plant species, species abundance, richness and evenness (similarity) has been calculated for each habitat type.

Result showed that Danaidae family is the most abundantly present in all the four habitats followed by Pieridae as per Kruskal-Wallis Test *i.e*. ranked first for the years 2011-12 & 2012-13. Hesperiidae was recorded the least abundant species as it ranked at seventh position for the years 2011-12 (Table-4 & 5). Community similarity study were based on the Jaccard's similarity index and it was observed that there were very much likeness in the communities present in all the eight study sites of GNPS as the values of Jaccard's similarity index obtained ranging from 0.71 to 1.00, which shows that most of the communities are common (Table-2 & 3). The species richness index as calculated was found to be the highest for Site-1 (23.44) while lowest for Site-2 (5.69). This clearly indicates that various types of species are present in Site-1 or it is richer in a number of species showing a total of about 50 species. At the same time, Site-2 recorded only 11 of these species. Similarly, species evenness index data showed Site-2 as the highest (1.14) which indicates that the total number of individuals present in Site-2 are evenly distributed between the 11 species. Site-1 has the lowest evenness (0.68) *i.e.* the species are more diverse here rather than showing a uniform distribution. Shannon-Weiner index of diversity takes into account both richness and evenness. Site-2 was reported the highest (1.74); therefore it indicates lower diversity in the site. While, Site-3 with the lowest index 1.40 shows that the site has more diversity of 50 species. Simpson's dominance index reveals the fact that Site-3 with value 0.31 do not show much of sharing of species but is abundant for few species. On the other hand, Site-2 with index value 0.19 shows sharing of species and is therefore not a dominant site. As per analysis of Kruskal-Wallis rank test, family Danaidae and Nymphalidae of butterflies stand out first which means that in the study of two years, the butterflies of these families were present in all the eight sites. This is a significant outcome revealing that Danaid and Nymphalid butterflies are very well adapted to the environment of Gir. The Dedakri range (Site-1) was found to be the best for the highest population of all the families of lepidopteron fauna. The diversity of butterflies has been observed higher in disturbed forest habitats in comparison to natural dense forests.

Table-1: The numbers of individuals within families of Lepidoptera captured and observed (2011-12 & 2012-13) under eight sites of four habitats

Family	Habitat 1						Habitat 2						Habitat 3		Habitat 4	
	Site-1		Site-2		Site-3		Site-4		Site-5		Site-6		Site-7		Site-8	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Lycaenidae	16	07	05	00	02	01	05	02	00	04	08	02	25	19	10	03
Pieridae	89	40	04	01	10	08	25	10	20	07	15	05	54	21	44	17
Nymphalidae	53	42	03	02	05	04	19	11	10	03	15	10	50	12	41	36
Papilionidae	10	07	04	02	00	00	07	05	03	05	06	02	18	12	11	05
Hesperiidae	05	04	06	03	05	05	03	02	04	06	03	03	02	02	05	06
Danaidae	24	29	15	10	30	32	40	23	34	21	22	20	14	05	09	06
Satyridae	05	02	07	05	08	10	03	02	05	05	07	04	03	01	02	02

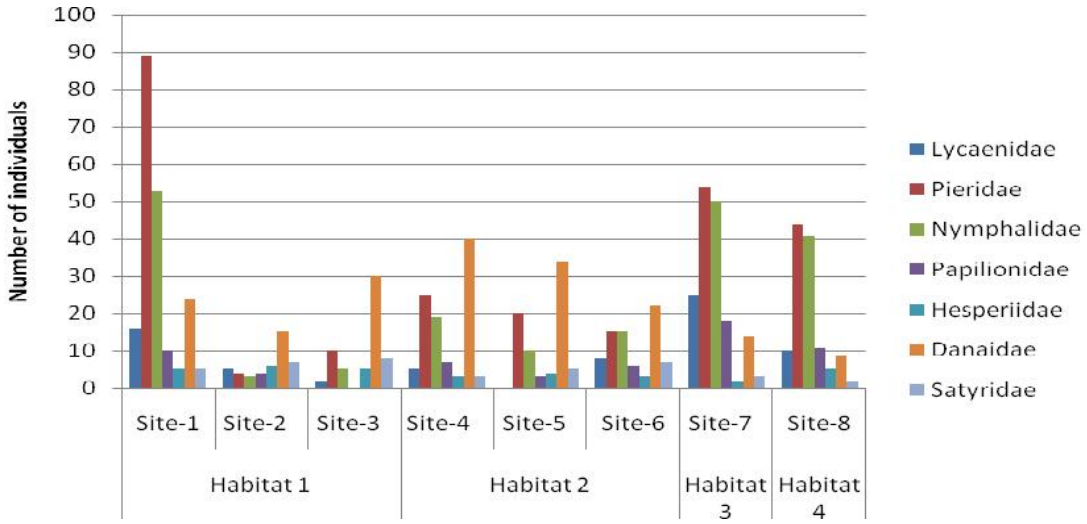


Fig.-1: Population of butterflies in eight sites of different habitat (2011-12)

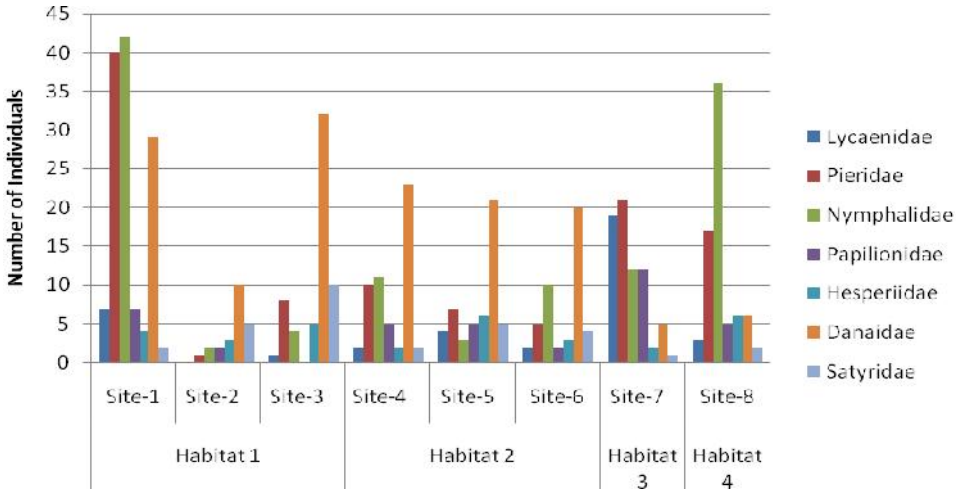


Fig.-2: Population of butterflies in eight sites of different habitat (2012-13)

Table-2: Jaccard's similarity index calculated based on butterfly species similarity for the year 2011-12 in GNPS

2011-12	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
Site 1	1.000							
Site 2	1.000	1.000						
Site 3	0.857	0.857	1.000					
Site 4	1.000	1.000	0.857	1.000				
Site 5	0.857	0.857	0.714	0.857	1.000			
Site 6	1.000	1.000	0.857	1.000	0.857	1.000		
Site 7	1.000	1.000	0.857	1.000	0.857	1.000	1.000	
Site 8	1.000	1.000	0.857	1.000	0.857	1.000	1.000	1.000

Table-3: Jaccard's similarity index calculated based on butterfly species similarity for the year 2012-13 in GNPS

2012-13	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
Site 1	1.000							
Site 2	0.857	1.000						
Site 3	0.857	0.714	1.000					
Site 4	1.000	0.857	0.857	1.000				
Site 5	1.000	0.857	0.857	1.000	1.000			
Site 6	1.000	0.857	0.857	1.000	1.000	1.000		
Site 7	1.000	0.857	0.857	1.000	1.000	1.000	1.000	
Site 8	1.000	0.857	0.857	1.000	1.000	1.000	1.000	1.000

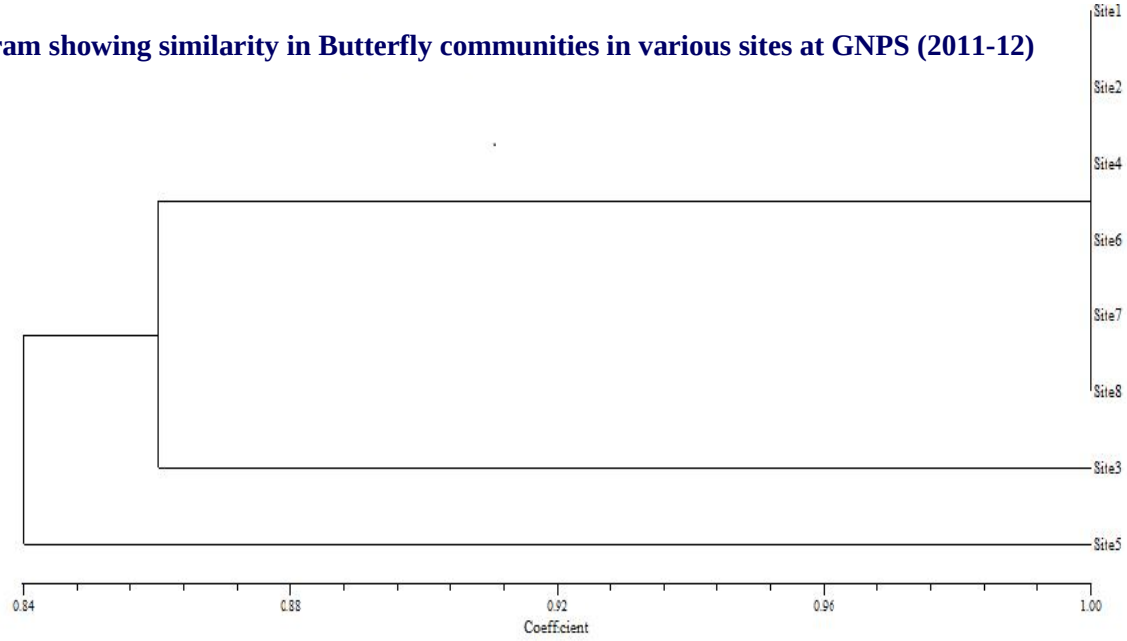
Table-4: Results from Kruskal-Wallis rank tests on the distribution of butterfly families among treatments (Site-1 to 8) for the year 2011-12 and 2012-13 in GNPS

Kruskal-Wallis Ranks Test		
	Mean Rank	
FAMILY	**2011-12**	**2012-13**
Lycaenidae	23.75	18.56
Pieridae	42	37.06
Nymphalidae	37.19	35.94
Papilionidae	22.63	23.19
Hesperiidae	14.13	21.38
Danaidae	**42.5**	**44.31**
Satyridae	17.31	19.06
Chi-Square (χ^2)	25.47	19.61
Df	6.00	6.00
Asymp. Sig. (P value)	0.000	0.003

Table-5: Data showing community similarity in butterflies

Habitat type	Species no.	Individual no.	Diversity (Shannon & Weiner index 1948)	Dominance (Simpson index 1949)	Species richness (Magurran index1988)	Species evenness (Pielou index1966)
SITE 1	169.0	1295	1.529	0.262	**23.443**	**0.686**
SITE 2	33.5	301	**1.743**	**0.190**	**5.695**	**1.143**
SITE 3	60.0	775	**1.404**	**0.314**	8.868	0.790
SITE 4	78.5	997	1.572	0.248	11.224	0.830
SITE 5	63.5	710	1.608	0.249	9.520	0.892
SITE 6	61.0	693	1.737	0.196	9.173	0.973
SITE 7	119.0	570	1.627	0.218	18.595	0.784
SITE 8	98.5	156	1.550	0.261	19.307	0.777

Dendrogram showing similarity in Butterfly communities in various sites at GNPS (2011-12)



Dendrogram showing similarity in Butterfly communities in various sites at GNPS (2013-14)

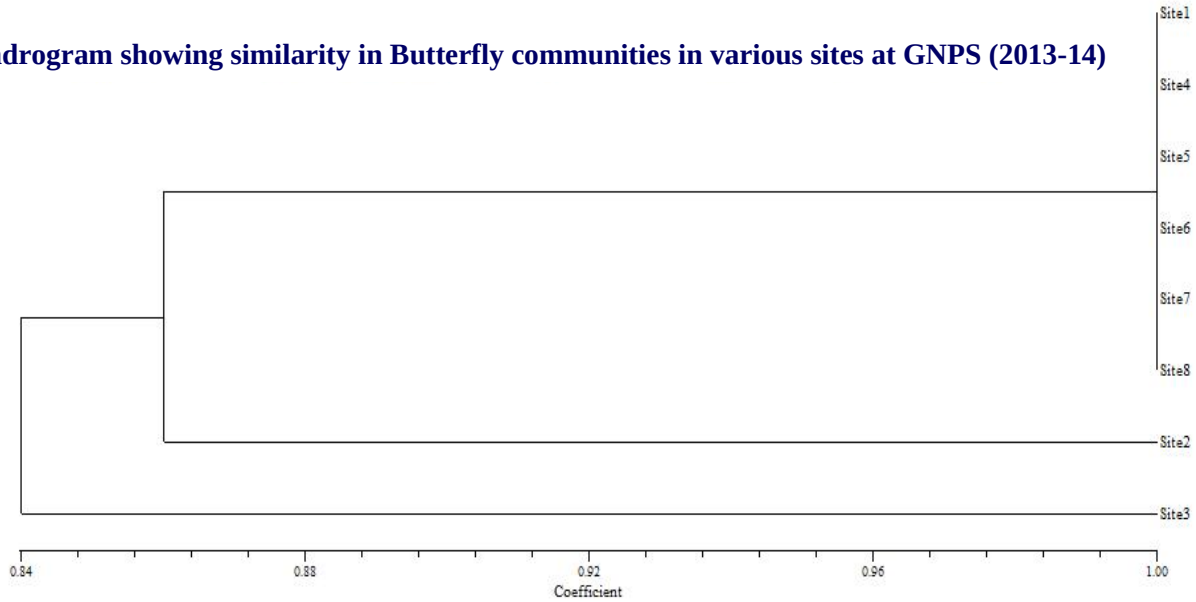


Table-6: Butterflies species observed from 2011 to 2013 in the eight ranges (Dedakadi, Visavadar, Babaria, Chhodvadi, Devalia, Jamwala, Sasan and Ankolwadi) in Gir wild life sanctuary

S. No.	Common Name	Scientific Name	Family
1.	The Lemon Pansy	*Junonia lemonias*	Nymphalidae
2.	The Blue Pansy	*Junonia orithya*	Nymphalidae
3.	The Yellow Pansy	*Junonia hierta*	Nymphalidae
4.	The Peacock Pansy	*Junonia almana*	Nymphalidae
5.	The Danaid Eggfly	*Hypolimnas misippus*	Nymphalidae
6.	Blue Tiger	*Tirumala limniace leopardus*	Danaidae
7.	Plain Tiger/African Monarch	*Danaus chrysippus*	Danaidae
8.	Stripped tiger	*Danaus genutia*	Danaidae
9.	The Common Indian Crow	*Euploea core*	Danaidae
10.	Common evening brown	*Melanitis leda*	Satyridae
11.	Common threering	*Ypthima asterope*	Satyridae
12.	Dark evening brown	*Melanitis phedima*	Satyridae
13.	The Baronet	*Euthalia nais*	Nymphalidae
14.	The Common Leopard	*Phalantha phalantha*	Nymphalidae
15.	The Common Nawab	*Charaxes athamas*	Nymphalidae
16.	Spotted joker	*Byblia ilithyia*	Nymphalidae
17.	Angled castor	*Ariadne ariadne*	Nymphalidae
18.	Painted lady	*Vanessa cardui*	Nymphalidae
19.	Tawny coster	*Acraea terpsicore* Syn. *A. violae*	Acraeidae
20.	The Lemon Emigrant	*Catopsilia pomona* Syn. *Catopsilia crocale*	Pieridae
21.	The Mottled Emigrant	*Catopsilia pyranthe*	Pieridae
22.	Yellow Orange Tip	*Ixias pyrene evippe*	Pieridae
23.	White Orange Tip	*Ixias marianne*	Pieridae
24.	The Pioneer White	*Belenois aurota* Syn. *Anaphaeis aurota*	Pieridae
25.	The Black veins	*Aporia hippia*	Pieridae
26.	Small orange tip	*Colotis etrida*	Pieridae
27.	Plain orange tip	*Colotis eucharis*	Pieridae
28.	Crimson tip	*Colotis danae*	Pieridae
29.	The Common Jezebel	*Delias eucharis*	Pieridae
30.	The Common Grass Yellow	*Eurema hecabe*	Pieridae
31.	Three spot Grass yellow	*Eurema blanda*	Pieridae
32.	Spotless grass yellow	*Eurema laeta*	Pieridae
33.	Broad bordered grass yellow	*Eurema brigitta*	Pieridae
34.	Common gull	*Cepora nerissa*	Pieridae
35.	Small white	*Pieris rapae*	Pieridae
36.	Large white	*Pieris brassicae*	Pieridae
37.	Common Lime Butterfly/ Chequered Swallowtail	*Papilio demoleus*	Papilionidae
38.	The Swallowtail	*Papilio veiovis*	Papilionidae
39.	Common Rose Swallowtail	*Pachliopta aristolochiae*	Papilionidae
40.	The Common Mormon	*Papilio polytes romulus*	Papilionidae
41.	Zebra butterfly	*Graphium nomius*	Papilionidae
42.	Common bluebottle	*Graphium sarpedon*	Papilionidae
43.	The common pierrot	*Castalius rosimon*	Lycaenidae

44.	Common guava blue	*Virachola isocrates*	Lycaenidae
45.	Forget-me-not	*Catochrysops strabo*	Lycaenidae
46.	Babul blue/ Topaz spotted blue	*Azanus jesous*	Lycaenidae
47.	Indian red flash	*Baspa mealampus*	Lycaenidae
48.	Stripped pierrot	*Tarucus nara*	Lycaenidae
49.	Common silverline	*Cigaritis vulcanus*	Lycaenidae
50.	Bright babul blue	*Azanus ubaldus*	Lycaenidae
51.	Formosan swift	*Borbo cinnara*	Hesperiidae
52.	Orange-tailed awl	*Bibasis sena sena*	Hesperiidae
53.	Malabar spotted flat	*Celanorrhinus ambareesa*	Hesperiidae

Discussion

This is the first study on the distribution and richness of species of butterflies in the forests of Gir. The interaction of host plant species with butterflies, their species abundance, richness and evenness (similarity) has been calculated for each habitat type. The disturbed forest was found as most ideal home for diverse population of lepidopteron fauna in comparison to the natural forests habitat. The Dedakri range was found to be the best for the highest population of all the families of lepidopteron fauna. This was on account of variety of food plants available for the butterflies in this range. Butterflies fauna for their reproduction require all type of vegetation like- Grasses, shrubs, herbs and trees which are very much present in this range. The rich floral diversity in tropical forests promotes herbivores, many of which are generalists (Price, 1997). According to Rosenzweig (1981), diversity is enhanced by presence of specialists that exhibit distinct habitat preferences. So, Dedakri range had vegetational complexity and multilayered canopy which provided different sets of microclimates within the range. This made the habitat distinct for different butterfly species.

Danaidae and Nymphalidae family butterflies were recorded the most abundant as they have broad host range or are polyphagous in habit. It also shows that these butterflies are very well adapted to the environment of Gir. Hesperiidae butterflies being small, dull colored and very active in flight could be difficult to be observed, so were recorded the least. The diversity of butterflies has been observed higher in thinned forest habitats in comparison to natural dense forests. The presence of dense understorey vegetation sometimes delimited by growing diverse herbs and shrubs serve a rich source of nectar for adult butterflies and food to developing larvae. A similar study focused on forest restoration, including thinning and burning treatments in northern Arizona, demonstrated increased species richness and abundance in treated areas of the ponderosa pine forest (Waltz and Covington 1999). Their study concluded that there was an increase in butterfly abundance, correlated with an increase in flowering plants, in response to restoration treatments. Also, butterflies in the research tenure responded more to the climatic conditions than to stand conditions (Pollard and Yates, 1993).

As illustrated in Red Data Book, the major threat to wild species is the destruction and alteration of habitats on which they depend. Deforestation, agricultural expansion in forest areas, alteration of grasslands through inappropriate grazing and scrub regeneration affect the population of species. Modification of habitat through conversion to plantation forestry and agriculture, intensification of agricultural and pastoral methods by use of fertilizers and pesticides generally reduce the diversity of invertebrate community (Wells *et al.*, 1984).

Since butterflies require all kinds of vegetation for survival of larval, pupal and adult stage, their ideal habitat should be a mixture of grasslands, herbs, shrubs, and flowering trees. Moreover, the regenerated lands are apt in providing other necessities for supporting their population. Presence of all such areas in Gir has turned out to be favorable for dwelling of various species of butterflies, and in turn, has rendered the status of healthy ecosystem to Gir forest . Recording of their flourishing population has proved them ecological indicators of Gir.

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