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DIVERSITY AND SEASONALITY OF BUTTERFLIES IN SARISKA TIGER RESERVE, RAJASTHAN

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ABSTRACT

Sariska tiger reserve is the famous tiger reserve in India. It is situated in Alwar district of Rajasthan state. It is endowed with unique flora and fauna. This tiger reserve surrounded by the oldest mountain ranges of Aravalli. The forest of type sariska tiger reserve is tropical dry deciduous, and dominant plant species are *Anogeissus pendula*, *Boswellia serrata*, *Acacia catechu*, *Dendrocalamus strictus*, *Butea monosperma*, *Capparis deciduas*, *Ziziphus maturittiana* etc. This region is come under the semi-humid climate zone with an average rainfall of 40 to 60mm. which directly influence the floral composition of that area. This present study mainly focuses on species diversity of butterflies and the effect of abiotic factors on diversity compositions in different seasons. The Seasonal survey of study site was done from June 2016 to July 2018. Seventeen hundred eighty four samples surveyed during sampling, which belongs to 38 species 26 genera and 5 families. Pieridae is the dominant family followed by Nymphalidae and Lycaenidae respectively, the least dominant family is Papilionidae and Hesperidae. During the field observation five transect were surveyed in different seasons. Diversity indices value shows that Sariska tiger reserve is rich in diversity. Abiotic factors viz. temperature, rainfall and humidity and species diversity correlation show a positive correlation with temperature and negative correlation with rainfall and humidity.

Key words: Biodiversity; Aravalli hill ranges; Sariska Tiger Reserve; Butterflies.

INTRODUCTION

Sariska tiger reserve situated at the Latitude & Longitude 27°22'0.33"N, 76°26'20.51"E with total area of 881 km^2 in Alwar district Rajasthan. According to authors Rajasthan is rich in flora and fauna (Dashahre et al., 2014; Dular 2013, 2015; Shahabuddin et al., 2006). Sariska tiger reserve come under the sub humid zone of climatic zone division. Aravalli hill mountain ranges surrounds the sariska tiger reserve and affect the geography and forest type of that area. According to Champioan and Seth (1968) foreste type of sariska tiger reserve is tropical dry deciduous with dominant plant species *Anogeissus pendula*.

Different authors indicate that India is rich in species diversity of butterflies (Kunte, 2000). 19,238 species of butterflies have been recorded worldwide by systematic studies (Sethy et al 2014; Alarape *et.al*. 2015) According to (kunte 2000) in India 1504 species of butterflies occur. Butterflies are the most important invertebrate species to study the effect of abiotic factors on the ecosystem (Gascon *et al.*, 1999; Rickets *et al*., 2001). Specific food habits in their different stage

of life make them important model species to study the effect of climate change and anthropogenic effect on habitat, ecosystem and biome (Iqbal and Younas, 2016). Therefore High species richness of butterflies indicate health ecosystem. Co-evolution of plant and pollinators affect the habitat of that particular ecosystem, like the habitat which is rich in species diversity of butterflies are rich in bright color flowering plant (Edgar *et. al.*,1974; Ehrlich and Raven 1964,). Systematic study and checklist of butterflies had prepared from different region of india (Biswas et al., 2017., Suryanarayana et al., 2016., Gogoi 2013., Bowalkar *et al*., 2017). In India sufficient work have been reported on species diversity of butterflies in different protect area like national parks wildlife sanctuaries, zoological parks and botanical gardens. Majumder *et al.*, 2012, observed in their study 59 species of butterfly belonging to 48 genera and five families were recorded from Trishna wildlife sanctuary,Tripura, northeast india. Gogi, 2013 preperaed preliminary checklist of 292 species of butterflies from Jeypore-Dehing forest, eastern Assam, India. where as in Seshachalam bio-reserve forest during the study period 106 species of butterflies were recorded by Suryanaryana et al., (2016).

In sariska tiger reserve not as much work has been reported on species diversity of butterflies. Least number of articles has been documented on diversity of butterflies from Sariska tiger reserve. This study provides much more information about the species diversity, seasonal diversity and affect of abiotic factors on the diversity of butterflies.

MATERIALS AND METHODS

Study site

Present study was done in Sariska Tiger Reserve (24.2411°N, 73.9499° E) covers an area of 866 km^2. This protected area got its status of national park in 1990. It is famous for its endemism of flora and fauna. It is hub of medicinal plant species (Punjani.2002). Dominant plant species are *Anogeissus pendula, zizyphus martiana, Acacia catechu, Acacia latifolia, Acacia nilotica, Abrus precatorius, Aegle marmelos*. Sariska tiger reserve is occupied by three types of forests which are mixed riparian forest, slope forests and scrub forests (Shahabuddin *et al.* 2004).

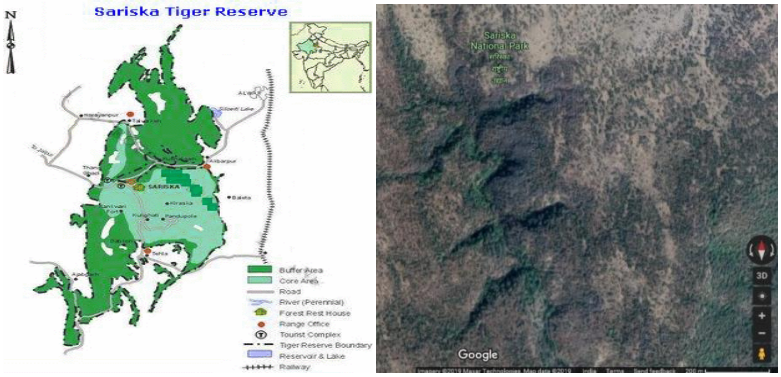


Fig.1 (a) Map of study site (source:google maps), (b) Satellite view of study site

Sampling methods

Sampling was done in different seasons during the year 2016 to 2017. Field survey and sampling was carried out by modified transect method during the early hour 9:00 to 1:00 and in the evening 5:00 to 7:00 hours (Pollard and Yates 1993). In the Sariska tiger reserve five transect were made of thousand meter and these five transect were revisit in different season for seasonal

sampling. Slow walk were conducted for proper sampling. Butterflies sampling were done by using different methods like visual count, catch and release method and photographs of samples. Identification of butterflies species were done by using field guide and the speciesmen which were difficult to identified in field were catches and photographed by using the Nikon camera for further identification by using different key (Roberts 2001).
Seasonal data of abiotic factors; temperature rainfall and humidity obtained from the secondary source (Meteorological department during the field survey).

STATISTICAL ANALYSIS

Field survey and observation are converted into the tables form. Data were analyzed and converted into graph by using Microsoft excel. Species diversity, species evenness and relative evenness were calculated by using different diversity indices. The relative abundance of butterflies species calculated by formula, Pi= Ni/N where Pi is the relative abundance; Ni is the individual of single species; N total number of species of selected area (Stiling, 1999). The species diversity were calculated by Shannon wiener diversity index having a formula H' = - [$\sum$ Pi ln Pi], where H' is the species diversity; Pi is Ni/N, and LnPi is natural logarithm of this Ni/N (Stiling, 1999). Species evenness shows that how evenly species are distributed in an area; species evenness was calculated by using a Pielou's evenness (1975), Species Evenness (J) = H'/ ln(S) Where, j is the species evenness; H' is Shannon Diversity Index, and S is Species Richness

Correlation of abiotic factors with species abundance, species evenness, and species richness is calculated by using a software SPSS. Rank abundance curve is used to show species richness and evenness in given area.

RESULTS AND DISCUSSION

Species diversity and species richness

Total Seventeen hundred eighty-four individual observed during sampling, which belongs to 38 species 26 genera and 5 families. Pieridae (36.16%) is the dominant family followed by Nymphalidae (30.78%) and Lycaenidae (27.19%) respectively, in this study the least abundant family is Papilionidae(1.3%) and Hesperidae (4.53%) (Table 1 & 2). *Eurema hecabe*, *Eurema blanda, Junonia lemonias Chilades putli, Eupleoea core,* these species are most encountered species during the field survey in all seasons while the *Cepora nerissa, Castalius rosimon* are least encounterd species (table 1& 2). Species abundance varies from season to seasons. In monsoon (July-September) average temperature was 30.66 ^{0}c, 60.66% humidity and 95.64mm rainfall was recorded while in post monsoon (October- November) average temperature was recorded 24.5^{0}c, 28.5% humidity and 0.78mm precipitation. In winter (December- march) average temperature was recorded 17.75^{0}c, 42.5% humidity and 7.69mm rainfall while in summer average temperature was recorded 35^{0}c, 23% humidity and average precipitation was 11.15mm. This data of temperature, humidity and rainfall obtained from the metrological department, Rajasthan during the survey period. Maximum number of species observed during the post monsoon season followed by monsoon, summer and winter respectively. Shannon index of diversity (H´=3.43 & 3.39), Simpson 'diversity index (D= 0.964 & 0.962) and Pielou' evenness index (J= 0.95 & 0.94) (table 2). Diversity indices of observed data indicate the rich species diversity of Sariska Tiger Reserve.

Table 1: Seasonal distribution of butterfly species in the year 2016-2017

Species	Monsoon n (%)	Postmonsoon n (%)	Summer n (%)	Winter n (%)	Total n (%)
Family: Hesperidae					
Coladenia indrani	3 (1.4)	8 (1.4)	3 (1.5)	1 (1.4)	15 (1.4)
Pelopidas mathias	2 (0.9)	8 (1.4)	8 (3.9)	2 (2.8)	20 (1.9)
Spialia galba	1 (0.5)	9 (1.6)	3 (1.5)	0	13 (1.2)
Family: Lycanidae					
Azanus jesous	8 (3.7)	3 (0.5)	12 (5.9)	0	23 (2.2)
Chilades lajus	9 (4.1)	21 (3.7)	12 (5.9)	0	42 (4)
Chilades putli	7 (3.2)	32 (5.7)	0	6 (8.3)	45 (4.2)
Castalius rosimon	2 (0.9)	8 (1.4)	0	2 (2.8)	12 (1.1)
Catochryspos Strabo	3 (1.4)	4 (0.7)	9 (4.4)	0	16 (1.5)
Euchrysops cnejus	6 (2.8)	21 (3.7)	9 (4.4)	0	36 (3.4)
Hypolycaena erylus	4 (1.8)	16 (2.8)	7 (3.4)	0	27 (2.5)
Leptotes plinius	6 (2.8)	9 (1.6)	0	0	15 (1.4)
Tarucus extricates	5 (2.3)	15 (2.7)	9 (4.4)	4 (5.6)	33 (3.1)
Tarucus nara	5 (2.3)	14 (2.5)	6 (2.9)	0	25 (2.4)
Zizula hylax	5 (2.3)	9 (1.6)	0	0	14 (1.3)
Family: Nymphalidae					
Cynthia cardui	5 (2.3)	16 (2.8)	0	6 (8.3)	27 (2.5)
Danus chrysipus	9 (4.1)	22 (3.9)	2 (1)	6 (8.3)	39 (3.7)
Eupleoea core	7 (3.2)	25 (4.4)	8 (3.9)	0	40 (3.8)
Hypolimnas bolina	8 (3.7)	16 (2.8)	9 (4.4)	4 (5.6)	37 (3.5)
Hypolimnas missipus	6 (2.8)	24 (4.2)	2 (1)	2 (2.8)	34 (3.2)
Junonia almanac	7 (3.2)	13 (2.3)	9 (4.4)	0	29 (2.7)
Junonia atlites	1 (0.5)	3 (0.5)	0	0	4 (0.4)
Junonia hierta	5 (2.3)	16 (2.8)	6 (2.9)	2 (2.8)	29 (2.7)
Junonia lemonias	9 (4.1)	20 (3.5)	7 (3.4)	10 (13.9)	46 (4.3)
Junonia orithia	4 (1.8)	16 (2.8)	7 (3.4)	3 (4.2)	30 (2.8)
Ypthima indica	3 (1.4)	6 (1.1)	0	2 (2.8)	11 (1)
Family: Papilionidae					
Papilio demodocus	5 (2.3)	6 (1.1)	3 (1.5)	0	14 (1.3)

Family: Pieridae					
Belenois aurota	5 (2.3)	21 (3.7)	13 (6.4)	2 (2.8)	41 (3.9)
Colotis etrida	3 (1.4)	15 (2.7)	8 (3.9)	0	26 (2.5)
Cepora nerissa	4 (1.8)	3 (0.5)	0	1 (1.4)	8 (0.8)
Catopsilia pyranthe	8 (3.7)	23 (4.1)	19 (9.3)	0	50 (4.7)
Eurema blanda	5 (2.3)	31 (5.5)	9 (4.4)	5 (6.9)	50 (4.7)
Eurema hecabe	21 (9.6)	45 (8)	13 (6.4)	12 (16.7)	91 (8.6)
Eurema laeta	5 (2.3)	8 (1.4)	0	0	13 (1.2)
Ixias Marianne	17 (7.8)	28 (5)	3 (1.5)	2 (2.8)	50 (4.7)
Ixias pyrene	10 (4.6)	14 (2.5)	8 (3.9)	0	32 (3)
Nepheronia argia	5 (2.3)	17 (3)	0	0	22 (2.1)
Total	218 (20.5)	565 (53.3)	204 (19.2)	72 (6.7)	1059 (100)

Table 2: Seasonal distribution of butterfly species in the year 2017-2018

	Monsoon n(%)	**Postmonsoon n(%)**	**Summer n(%)**	**Winter n(%)**	**Total n(%)**
Family: Hesperidae					
Coladenia indrani	3 (2)	4 (1)	1 (1.2)	2 (1.8)	10 (1.4)
Pelopidas mathias	2 (1.3)	5 (1.3)	0	0	7 (1)
Spialia galba	3 (2)	9 (2.3)	2 (2.4)	0	14 (1.9)
Family: Lycanidae					
Azanus jesous	7 (4.6)	12 (3.1)	4 (4.8)	0	23 (3.1)
Chilades lajus	4 (2.6)	9 (2.3)	2 (2.4)	3 (2.8)	18 (2.5)
Chilades putli	3 (2)	13 (3.3)	4 (4.8)	5 (4.6)	25 (3.4)
Castalius rosimon	3 (2)	4 (1)	0	0	7 (1)
Catochryspos Strabo	3 (2)	5 (1.3)	0	0	8 (1.1)
Euchrysops cnejus	5 (3.3)	18 (4.6)	0	0	23 (3.1)
Hypolycaena erylus	0	3 (0.8)	0	0	3 (0.4)
Leptotes plinius	2 (1.3)	4 (1)	0	0	6 (0.8)
Tarucus extricates	5 (3.3)	7 (1.8)	2 (2.4)	2 (1.8)	16 (2.2)
Tarucus nara	2 (1.3)	9 (2.3)	0	0	11 (1.5)
Zizula hylax	0	3 (0.8)	0	4 (3.7)	7 (1)
Family: Nymphalidae					

Cynthia cardui	4 (2.6)	8 (2.1)	2 (2.4)	3 (2.8)	17 (2.3)
Danus chrysipus	7 (4.6)	17 (4.4)	6 (7.1)	5 (4.6)	35 (4.8)
Eupleoea core	6 (4)	14 (13.6)	3 (3.6)	8 (7.3)	31 (4.2)
Hypolimnas bolina	8 (5.3)	16 (4.1)	9 (10.7)	4 (3.7)	37 (5)
Hypolimnas missipus	7 (4.6)	14 (3.6)	4 (4.8)	4 (3.7)	29 (4)
Junonia almanac	5 (3.3)	12 (3.1)	4 (4.8)	2 (1.8)	23 (3.1)
Junonia atlites	2 (1.3)	6 (1.5)	0	0	8 (1.1)
Junonia hierta	6 (4)	13 (3.3)	3 (3.6)	5 (4.6)	27 (3.7)
Junonia lemonias	7 (4.6)	15 (3.9)	4 (4.8)	8 (7.3)	34 (4.6)
Junonia orithia	2 (1.3)	4 (1)	0	0	6 (0.8)
Ypthima indica	5 (3.3)	8 (2.1)	1 (1.2)	2 (1.8)	16 (2.2)
Family: Papilionidae					
Papilio demodocus	2 (1.3)	5 (1.3)	3 (3.6)	4 (3.7)	14 (1.9)
Family: Pieridae					
Belenois aurota	2 (1.3)	10 (2.6)	1 (1.2)	5 (4.6)	18 (2.5)
Colotis etrida	7 (4.6)	14 (3.6)	4 (4.8)	6 (5.5)	31 (4.2)
Cepora nerissa	2 (1.3)	6 (1.5)	0	3 (2.8)	11 (1.5)
Catopsilia pyranthe	7 (4.6)	12 (3.1)	6 (7.1)	5 (4.6)	30 (4.1)
Eurema blanda	8 (5.3)	18 (4.6)	4 (4.8)	4 (3.7)	34 (4.6)
Eurema hecabe	6 (4)	45 (11.6)	4 (4.8)	9 (8.3)	64 (8.7)
Eurema laeta	6 (4)	20 (5.1)	5 (6)	7 (6.4)	38 (5.2)
Ixias Marianne	4 (2.6)	13 (3.3)	6 (7.1)	9 (8.3)	32 (4.4)
Ixias pyrene	4 (2.6)	9 (2.3)	0	0	13 (1.8)
Nepheronia argia	2 (1.3)	5 (1.3)	0	0	7 (1)
Total	151 (20.6)	389 (53.1)	84 (11.4)	109 (14.8)	733 (100)

Table 3: Species diversity, richness and evenness in Sariska Tiger Reserve.

Diversity indicies	**2016 to 2017**	**2017 to 2018**
Species diversity (H)	3.43	3.39
Species richness (D)	0.964	0.962
Species evenness (J)	0.958	0.946

Seasonality and butterfly's abundance

Climatic factors like temperature humidity and precipitation are considered to be important factors for the species composition of butterflies in Sariska tiger reserve. These factors also seem to be play important role in the type of vegetation of that area. Sariska tiger reserve comprises scrub-thorn arid forests, dry deciduous forests, grasslands, and rocky hills. Parmar (1985) and Rodgers (1985), classified forest of sariska tiger reserve into *Anogeissus pendula* forest, *Boswellia serrata* forest, *Acacia catechu* forest, and *Miscellaneous* forest. Seasonality affects the species composition in different months. Observed seasonal pattern in butterflies mainly control by the temperature and less impact of rainfall and humidity. In post-monsoon (October-November) less humidity and moderate average temperature and less rainfall support the large number of butterflies species.

In summer there is high very high temperature during the day and less rainfall and humidity, due to dry condition support very less flora generally plant are with very less number of leaves (dry deciduous forest).which support less number of larval and adult host plant of butterflies, directly affect the number of species of butterflies composition during the summer (April-June). In summer 28 species were encountered during the survey. In winter and monsoon temperature is low which also affect the species number of butterflies in that particular area. In our study we observed that availability of larval host plat and adult nectars plant directly related with the of species abundance. Besides the habitat, statistical analysis of our obsevered data also shows that abiotic factors like temperature, rainfall and humidity repercussion the specie composition of butterflies.

Person's correlations test applied to calculate correlation between species richness and abiotic factors. Temperature shows a positive correlation at the values (r= 0.021, p-value=0.90) with species richness while precipitation and humidity shows a negative correlation at the r= -0.181,p-value -0.29 and r= -0.17, p-value -0.32 respectively (Table 4 & 5).

Table 4: Correlation of physical factors with species richness for the year 2016

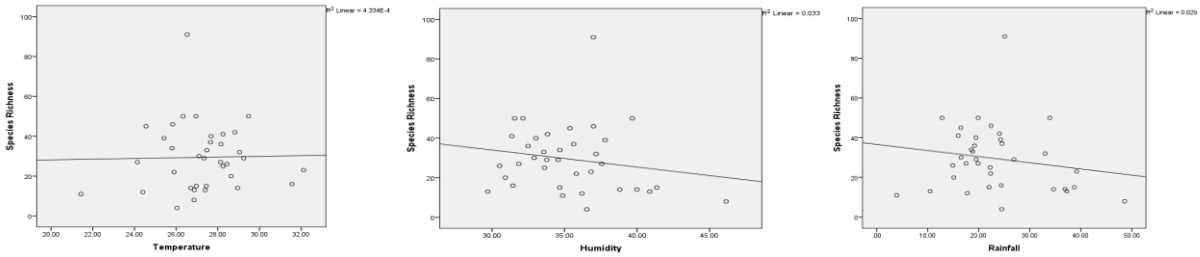
Physical factors	Species richness	
	R	**p-value**
Temperature	0.021	0.904
Humidity	-0.181	0.291
Rainfall	-0.17	0.32

Test applied: Pearson's correlation test, r= Correlation coefficient

Table 5: Correlation of physical factors with species richness for the year 2017

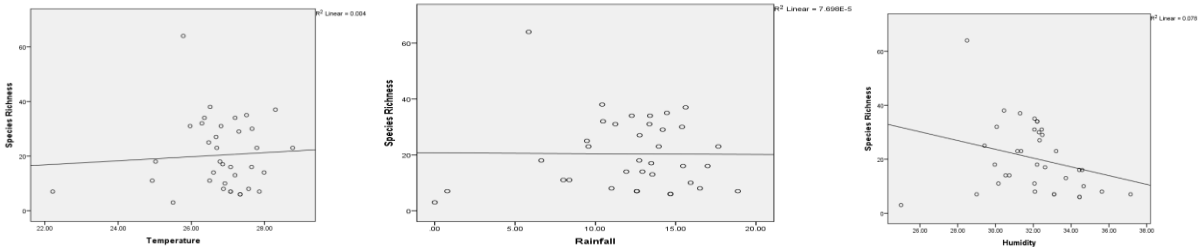
Physical factors	Species richness	
	R	**p-value**
Temperature	0.065	0.704
Humidity	-0.28	0.098
Rainfall	-0.009	0.959

Test applied: Pearson's correlation test, r= Correlation coefficient



(a) (b) (c)

Fig.2: (a) Positive correlation between species richness and temperature. (b) negative correlation between species richness and humidity, (c) negative correlation between species richness and rainfall (2016-2017).



(a) (b) (c)

Fig.3: (a) Positive correlation between species richness and temperature. (b) negative correlation between species richness and humidity, (c) negative correlation between species richness and rainfall (2017-2018).

Our study on species diversity of butterflies shows clear cut seasonality with species abundance, October and November shows peak. Species diversity across the year depends in Sariska tiger reserve on many climate factors, habitat and host plant availability. In different seasonal species activity is influence by the temperature, rainfall and humidity. These climatic factors affect the seasonality of butterflies like some species are very active and abundant in post monsoon (October-November) due to moderate temperature and low rainfall and humidity as compare to the other months of the year.

This study of seasonal variation in species diversity are supported by previous work in, seasonal peaking activity of butterflies in different months by (Farnzen et al., 2017). Kunte 1997, same work also has been carried out and identified two seasons as peaks, March-April and October, for butterfly abundance. Correlation study suggested that species richness is positively correlated with the temperature and negatively correlated with rainfall and humidity. Islam et al., 2013, found relation between abiotic factors and butterflies abundance.

We observed that some species are very frequent throughout the year, and few species shows seasonality peak at particular months. *Eurema hecabe, Ixias pyrene, Danus chrysipus, Eucrema baland, Cynthia cardui* shows their activity throughout the year, *Junonia almanac, Junonia orithia, Azanus jesous, Leptotes plinius, Hypolycaena erylus* shows seasonality,active at

particular month of the year. Many butterflies' species under the family Nymphalidae and hesperiidae are highly mobile. Mobility of species affects the species abundance and richness of habitat (Stevens et al. 2010). Weather directly influence the population size and abundance (Roy et al. 2001; Franzen and Nilsson 2012).

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