



BUTTERFLY DIVERSITY AND THEIR RELATIVE ABUNDANCE IN A SUB-TROPICAL WETLAND HABITAT IN HARKUL-KHURD VILLAGE, KANKAVLI, SINDHUDURG, MAHARASHTRA, M.S. INDIA

Aparna Ashok Ghadi, Manisha Kulkarni

1. Research Scholar, Department of Zoology, The Institute of Science, Mumbai, Maharashtra 400032, India.
2. Department of Zoology, The Institute of Science, Mumbai, Maharashtra 400032, India.

Abstract: This study was conducted to record the diversity of butterflies in the surrounding areas of Harkul Khurd wetland in Sindhudurg district of Maharashtra, during January 2020 to January 2022. A total of 121 butterfly species were recorded which belong to six different families such as Hesperidae, Lycaenidae, Nymphalidae, Papilionidae, Pieridae and Riodinidae. The highest number was recorded from family Nymphalidae (43 species, 35.53%) followed by Hesperidae and Lycaenidae (23 and 22 species with 19.00% and 18.18% of relative abundance respectively) however, in Pieridae and Papilionidae recorded 17 and 15 species with 14.04% and 12.39% of relative abundance respectively. The lowest number was recorded from family Riodinidae, single specie with 0.82% relative abundance. Species composition varied significantly ($F = 93.85$; $P < 0.05$) among forest ranges in Harkul Khurd village; 93 butterfly species were common at different forest ranges in Harkul Khurd village, but 28 species were confined to specific forest ranges. Nymphalidae had the highest (43) species composition compared to other families. The genus Junonia (Pansies) was represented by six species, followed by Papilio and Eurema with nine species each. The Shannon diversity index ranged between 1.53 and 1.58 and the Simpson and Shannon 'J' (Equitability) indices were 0.97 and 0.94, suggesting evenness between the forest ranges. Thus, the present study provided deep insight into the butterflies of Harkul Khurd village and further research is needed for restoration of forest habitats in Harkul Khurd village.

Index Terms -Butterfly Diversity, Harkul-Khurd village, Species Composition, Sindhudurg District, Sustainable Development, Western Ghats, Wetland.

INTRODUCTION:

The Harkul-khurd village is in the Sindhudurg district and it is a part of northern Western Ghats between 15° N to 20° N latitudes. Western Ghats is one of the 34 biodiversity hotspots of the world (Mittermeier et al. 2005) indicated that India harboured total 1504 of butterfly species which accounted 8.74% of the world's butterfly and 285 species found in southern India. The peninsular India and Western Ghats have 351 and 334 species respectively. The study area is covered in diverse ecosystems that provide a suitable habitat to the butterflies.

Empirical studies show that the Indian subcontinent hosts about 1,318 species of butterflies (Varshney & Smetacek, 2015). Over the last few decades, however, various anthropogenic activities and sudden climatic change conditions have led to modification of the habitat structure and function which in turn negatively influenced butterfly diversity (Clark et al. 2007). Therefore, the diversity studies of butterflies are critical to determine the effects of urbanization on butterfly communities and other aspects of biodiversity conservation (Blair 1999; Singh & Pandey 2004; Clark et al. 2007; Mukherjee et al. 2015). Butterfly diversity indirectly also reflects the diversity of various plant communities (Murugesan et al. 2013; Mukherjee et al. 2016).

Butterflies (Lepidoptera: Papilionoidea) due to their strong intricate links in the food web they are an important component of biodiversity in natural ecosystems (Bonebrake et al., 2010). Butterflies are vibrant insects with scaly wings that belong to the order Lepidoptera in the class Insecta. Butterflies provide many

economically important services within terrestrial ecosystems such as nutrients recycling, soil formation, food resources and pollination (Pahari et al. 2018) and also recommended that the anthropogenic activities can affect the butterflies and their relative abundance in a particular habitat. Numerous butterfly species act as biological indicators of environmental health and ecological changes (Hill 1999; Kocher & Williams 2000; Koh & Sodhi 2004; and Thomas 2005) as they can be very sensitive to habitat fragmentation and climate change (Kunte 2000). Leon-Cortes et al. (2019) reported that the most diverse species of butterfly are belonging to the Nymphalidae family which is one of the dominant families with highest number of species. Butterfly diversity indirectly also reflects the diversity of various plant communities (Murugesan et al. 2013; Mukherjee et al. 2016). Pollard (1988) reported that biotic and abiotic factors also influence butterfly populations, indicating the bio-indication potential of the group. There are numerous reports by various investigators on butterfly diversity from different parts of India (Bhaskaran & Eswaran 2005; Tiple et. al. 2006; Nimbalkar et al. 2011; Tiple 2011; Kunte et al. 2012 and Majumder et al. 2012).

MATERIALS AND METHODS:

Study area Butterfly surveys were conducted within 5 km radius of the Harkul Khurd Wetland, located in Sindhudurg District of Maharashtra (Figure 1). Geographically, the study area is located at an elevation of 80 meters above the sea level in the Boom Range of the Northern Western Ghats, which is located between 16.2655° N Latitude and 73.7083° E Longitude. The subtropical climate of Harkul Khurd Lake is bordered by hills that are somewhat densely vegetated (Figure 2). It is famous for the significance of its own culture, religion, and spirituality.

The butterflies were observed in the surrounding areas of the Harkul Khurd wetland which is located in the Harkul Khurd village in Sindhudurg district from various ecosystems viz. forests, grassland, agricultural land, bushy areas, wetland etc. Survey for butterflies was made in all the four seasons namely, winter, summer, monsoon and post -monsoon from January, 2020 to January, 2021. The study areas were surveyed thrice a week and the data were documented. The data on butterfly diversity and its relative abundance were recorded based on visual observation of the individual butterfly species and also by photographic documentation. The survey was made from morning 07.00 a.m. to 11.30 a.m. Line transect count method according to Kunte (2000) were followed to find the individual species and their relative abundance in respective habitat. The relative abundance (RA) of each individual species in a study area was calculated as a percentage by considering the total counts of each species in relation to the entire individuals counted during the study period. The transects were fixed in the routes along the paths once in a week covering an area of 50 meter around a radius of 5 meter front from the observer and 2.5 meter on either sides. All zoological names and identification used in the present study are in accordance with Varshney (1983), Kehimkar (2008), and common English names were used from Wynter-Blyth (1957). The observed butterflies were categorized into five groups on the basis of their relative abundance in their habitat as VC- very common (31- 35 sightings), C- common (45- 50 sightings), LC- less common (20-25 sightings), R- Rare (13-15 sightings), VR- very rare (12-15 sightings). The diversity indices and evenness were worked out by following Shannon Wiener diversity index.



Figure 1. Geographical location of study area: (a) Study transects (indicated in yellow lines) in surrounding areas of Harkul Khurd Wetland of Sindhudurg District of state Maharashtra, India and (b) Harkul Khurd 15° N to 20° N latitudes (Google Earth, 2020)



Fig. 2. An image of Harkul Khurd Wetland located in a sub-tropical environment of the northern Western Ghats.

RESULTS & DISCUSSION:

During the study period (2020-22), a total of 121 adult individuals classified into 74 species and 56 genera under six families (Table 1 to 6) were recorded from the Harkul Khurd Wetland which is the part of Northern Western Ghats. Figures 4 show photographs of the some of the reported butterflies from the study area. Family Nymphalidae consisted the highest number of species (35.53% species), followed by Hesperiiidae (19.00 % species), Lycaenidae (18.18% species), Pieridae (14.04% species), Papilionidae (12.39% species) and Riodinidae (0.82% species) of relative abundance. Margalef's richness value during the autumn is ($H_m = 19.03$), followed by winter season ($H_m = 18.19$) monsoon ($H_m = 13.64$), while the least value was obtained in the summer season ($H_m = 12.13$). The seasonal index values for the Nymphalids were almost similar in the summer season at the time of the study period, highest during September and then declined sharply till the end of January. The second peak of abundance was observed during autumn. The seasonal index for the Hesperiiidae and Lycaenidae families shows that the abundance peak in the autumn and then declined till the end of the season. The abundance started building from the onset of the post monsoon season and peaked during September, then declined moderately till the end of the October. The results of the one-way ANOVA analysis revealed that there were significant seasonal differences in both the total species richness and abundance of butterflies (Species richness: $F = 17.512$ and $P < 0.005$ Species abundance: $F = 6.431$ and $P < 0.005$). Five species are listed under different schedules of the Indian Wildlife (Protection) Act 1972 (Table 1 to 6). Species namely *Lampides boeticus* L. is legally protected under Schedule II, whereas *Euploea core* C. is legally protected under Schedule IV of the act. As per the IUCN Red list of Threatened Species, none of the reported butterfly is endangered or threatened globally.

The Harkul Khurd Wetland and its surrounding areas have not received the attention of conservationist for the sustainable development of the Butterfly diversity. In order to maintain a wide variety of butterfly fauna in the wetland environment, this study emphasizes the importance of varied ecological factors and a mosaic of flora in the northern Western Ghats. This is the first attempt to determine the diversity of butterflies and their relative abundance in the diverse habitats of the Harkul Khurd wetland and its surround areas which is the part of the Northern Western Ghats. Butterfly richness and their abundance accounted to the total of 101 known butterfly species from the Amboli village in Sindhudurg district during the years 2013 which in the very close vicinity to the study area (Padhye et.al., 2013).

Further, the findings of the study confirmed with the findings of (Rajagopal et al. 2011; Ackery et al., 1988) who found that the temperature precipitation is also a vital factor that directly influence the butterflies richness and population. Earlier studies by (Kunte, 2001; Chakaravarthy et al. 1997; Hussain et al., 2011) also indicated that temperature and rainfall are two important factors which directly influence the butterflies richness and population. The detailed study clearly expresses the ecological importance of the highly biodiverse ecosystem of the Harkul Khurd village in the Sindhudurg district of south Maharashtra, the conservation status coincided with (Anand et al.1986-2021). In the northern Western Ghats, the ultimate breeding season for most of the butterfly species is post Monsoon and it continues till winter. The results of the present study coincided with the butterfly movement from October to January/February at Nilgiri and Annamalai hills of southern Western Ghats (Kunte, 2005). The Shannon-Wiener diversity index of the butterfly families collected in the study area indicated that the Nymphalidae was rich in species diversity with 1.47 than other families. The evenness was also found more with Nymphalidae matched with the results of (Mirza, et al., 2010).

CONCLUSION:

Anthropogenic disturbances, such as tourism, an increase in water pollution, and over-exploitation of the forest resources in the wetland's surrounding areas, are one of the observed threats to the butterfly species in the Harkul Khurd village of the Sindhudurg district. Excessive plant logging and grazing on the grasses resulting into the habitat destruction which serves feeding and host plants for the butterflies. The relative abundance and diversity of butterflies in the study region can be affected of habitat destruction and degradation. These interferences are degrading the habitat quality and negatively harming the host and nectar plant supplies of butterflies, which in turn is affecting the taxonomic diversity of those species. It is crucial to conserve the diversity of butterflies in the study area since they are an integral part of the ecosystem. The Harkul Khurd Wetland and its surrounding areas in the Sindhudurg district has the potential to be a butterfly eco-tourism destination and presents a chance to raise awareness of conservation efforts among the local population. Also the butterfly species composition in the study area and nearby areas will need to be monitored and studied in the future for their sustainable development. The diverse natural habitats of Harkul Khurd wetland harbour the rich butterfly fauna. The occurrence of rich butterfly diversity including several rare, habitat specific, legally protected and endemic butterfly species of the Western Ghats increased the conservation value and wildlife status of the Harkul Khurd village in the Sindhudurg district of the northern Western Ghats. It is strongly advised that the study area should be declared as an in-situ conservation region in order to protect the butterfly species and wetland habitat due to the study region harbours a varied diversity of the butterfly fauna, which must be conserved for ecological integrity.

Sr. No.	Common Name	Scientific Name	Relative Abundance	Seasonal Occurrence
Family: Hesperiiidae (Skippers)				
Subfamily: Coeliadinae (Awls, Awlets and Awlkings)				
01	Orange Awlet	<i>Burara jaina fergusonii</i>	VR	M, A
Subfamily: Pyrginae (Flats and Angles)				
02	Malabar Spotted Flat	<i>Celaenorrhinus ambareesa</i>	LC	S,M,A,W
03	Common Spotted Flat	<i>Celaenorrhinus leucocera (Kollar)</i>	C	S,M,A,W
04	Common Small Flat	<i>Sarangesa dasahara dasahara</i>	C	S,M,A,W
05	Spotted Small Flat	<i>Sarangesa purendra Moore</i>	VR	S,M,A,W
06	Tricolour Pied Flat	<i>Coladenia indrani indra Moore</i>	LC	M,A,W
07	Common Snow Flat	<i>Tagiades japetus helferi</i>	R	M,A
08	Water Snow Flat	<i>Tagiades litigiosa Möschler</i>	VR	M,A
09	Chestnut Angle	<i>Odontoptilum angulata (C. Felder, 1862)</i>	R	S,M,A,W
10	Golden Angle	<i>Caprona ransonnetti</i>	VR	S,M,A,W
Subfamily: Hesperinae (Darters, Darts, Dartlets, Swifts, Aces, Bobs, Redeyes, Demons)				
11	Common Dartlet	<i>Oriens gola (Moore)</i>	R	S,A,W
12	Grey-veined Grass Dart	<i>Taractrocera maevius (Fabricius)</i>	VR	A,W
13	Straight Swift	<i>Parnara guttatus (Bremer & Grey, [1852])</i>	C	S,A,W
14	Rice Swift	<i>Borbo cinnara (Wallace, 1866)</i>	C	A,W
15	Lesser Rice Swift	<i>Borbo bevani (Moore, 1878)</i>	R	M,A,W
16	Great Swift	<i>Pelopidas assamensis (de Nicéville, 1882)</i>	VR	W
17	Conjoined Swift	<i>Pelopidas conjuncta (Herrich-Schäffer, 1869)</i>	C	M,A,W
18	Common Redeye	<i>Matapa aria (Moore, [1866])</i>	LC	S,A,W
19	Chestnut Bob	<i>Iambrix salsala (Moore, [1866])</i>	VR	M,A,W
20	Restricted Demon	<i>Notocrypta curvifascia (C. & R. Felder, 1862)</i>	C	A,W
21	Grass Demon	<i>Udaspes folus (Cramer, [1775])</i>	C	W
22	Bush Hopper	<i>Ampittia dioscorides (Fabricius, 1793)</i>	LC	M,A,W
23	Pygmy Scrub Hopper	<i>Aeromachus pygmaeus (Fabricius, 1775)</i>	LC	S,A,W

Table 1: Butterflies of Family: Hesperiiidae (Skippers) recorded at Harkul Khurd village of Sindhudurg district, Maharashtra.

Sr. No.	Common Name	Scientific Name	Relative Abundance	Seasonal Occurrence
Family: Papilionidae (Swallowtails)				
Subfamily: Papilioninae				
01	Common Jay	<i>Graphium doson</i> (C. & R. Felder, 1864)	C	S,M,A,W
02	Tailed Jay	<i>Graphium agamemnon</i> (Linnaeus, 1758)	C	S,M,A,W
03	Common Mime Male	<i>Papilio clytia</i> Linnaeus, 1758	LC	S,M,A,W
04	Common Mime Female	<i>Papilio clytia</i> Linnaeus, 1758	LC	M,A,W
05	Common Mormon Male	<i>Papilio polytes</i> Linnaeus, 1758	C	S,M,A,W
06	Common Mormon Female (Form romulus)	<i>Papilio polytes</i> Linnaeus, 1758	C	S,M,A,W
07	Common Mormon Female (Form stichius)	<i>Papilio polytes</i> Linnaeus, 1758	C	S,M,A,W
08	Blue Mormon	<i>Papilio polymnestor polymnestor</i>	C	S,M,A,W
09	Lime Butterfly	<i>Papilio demoleus</i> Linnaeus, 1758	VC	S,M,A,W
10	Common Yellow Swallowtail	<i>Papilio machaon</i> Linnaeus, 1758	C	S,M,A,W
11	Malabar Banded Peacock	<i>Papilio buddha</i> Westwood, 1872	LC	A,W
12	Common Rose	<i>Pachliopta aristolochiae</i> (Fabricius, 1775)	LC	S,W
13	Crimson Rose	<i>Pachliopta hector</i> (Linnaeus, 1758)	VC	S,W
14	Common Birdwing	<i>Troides helena</i> (Linnaeus, 1758)	VR	S,A,W
15	Southern Birdwing	<i>Troides minos</i> (Cramer, [1779])	R	S,A,W

Table 2 : Butterflies of Family: Papilionidae (Swallowtails) recorded at Harkul Khurd village of Sindhudurg district, Maharashtra.

Sr. No.	Common Name	Scientific Name	Relative Abundance	Seasonal Occurrence
Family: Pieridae (Whites and Yellows)				
Subfamily: Coliadinae (Yellows)				
01	One Spot Grass Yellow	<i>Eurema andersonii</i> (Moore, 1886)	VC	M,A,W
02	Small Grass Yellow	<i>Eurema brigitta</i> (Stoll, [1780])	VC	A,W
03	Common Grass Yellow	<i>Eurema hecabe</i> (Linnaeus, 1758)	VC	A,W
04	Common Emigrant	<i>Catopsilia pomona</i> (Fabricius, 1775)	VC	S,M,A,W
05	Mottled Emigrant	<i>Catopsilia pyranthe</i> (Linnaeus, 1758)	VR	S,M,A,W
Subfamily: Pierinae (Whites)				
06	Small Salmon Arab	<i>Colotis amata</i> (Fabricius, 1775)	LC	A,W
07	Small/Little Orange Tip	<i>Colotis etrida</i> (Boisduval, 1836)	R	A,W
08	Plain Orange Tip	<i>Colotis eucharis</i> (Fabricius)	C	A,W
09	Large Salmon Arab	<i>Colotis fausta</i> (Olivier, 1804)	C	S,M,A,W
10	White Orange Tip	<i>Ixias marianne</i> (Cramer, [1779])	C	S,M,A,W
11	Yellow Orange Tip	<i>Ixias pyrene</i> (Linnaeus, 1764)	C	M,A
12	Andaman Great Orange Tip	<i>Hebomoia roepstorffii</i> Wood-Mason, 1880	LC	M,A
13	Common/Indian Wanderer Male	<i>Pareronia hippia</i> (Fabricius, 1787)	VC	S,M,A,W
14	Common Wanderer Female	<i>Pareronia hippia</i> (Fabricius, 1787)	C	S,M,A,W
15	Common Gull	<i>Cepora nerissa</i> (Fabricius, 1775)	VC	S,M,A,W
16	Common Jezebel	<i>Delias eucharis</i> (Drury, 1773)	C	S,M,A,W
17	Psyche	<i>Leptosia nina</i> (Fabricius, 1793)	VC	S,M,A,W

Table 3: Butterflies of Family: Pieridae (Whites and Yellows) recorded at Harkul Khurd village of Sindhudurg district, Maharashtra.

Sr. No.	Common Name	Scientific Name	Relative Abundance	Seasonal Occurrence
Family: Lycaenidae (Blues)				
Subfamily: Miletinae (Brownies, Mottles, Forest Pierrot and Apefly)				
01	Apefly	<i>Spalgis epius</i> (Westwood, [1851])	VR	M,A
Subfamily: Theclinae (Strong Blues)				
02	Yamfly	<i>Loxura atymnus</i> (Stoll, 1780)	VC	M,A,W
03	Monkey Puzzle	<i>Rathinda amor</i> (Fabricius, 1775)	R	S,M,A,W
04	Common Silverline	<i>Spindasis vulcanus</i> (Fabricius, 1775)	VC	S,M,A,W
Subfamily: Polymmatinae (Weak Blues)				
05	Angled Pierrot	<i>Caleta decidia</i> (Hewitson, 1876)	C	M,A
06	Common Pierrot	<i>Castalius rosimon</i> (Fabricius, 1775)	C	A,W
07	Common Cerulean	<i>Jamides celeno</i> (Cramer, [1775])	VC	S,M,A,W
08	Metallic Cerulean	<i>Jamides alecto</i> (C. Felder, 1860)	LC	A,W
09	Silver Forget-Me-Not	<i>Catochrysops panormus</i> (C. Felder, 1860)	VC	S,A,W
10	Forget-Me-Not	<i>Catochrysops strabo</i> (Fabricius, 1793)	C	S,M,A,W
11	Pea Blue	<i>Lampides boeticus</i> (Linnaeus, 1767)	VC	S,M
12	Dark Grass Blue	<i>Zizeeria karsandra</i> (Moore, 1865)	VC	A,W
13	Pale Grass Blue	<i>Pseudozizeeria maha</i> (Kollar, [1844])	C	W
14	Grass Jewel	<i>Freyeria trochylus</i> (Freyer, 1845)	C	A,W
15	Lesser Grass Blue	<i>Zizina otis</i> (Fabricius, 1787)	VR	A,W
16	Tiny Grass Blue	<i>Zizula hylax</i> (Fabricius, 1775)	VC	A,W
17	Indian Cupid	<i>Everes lacturnus</i> (Godart, [1824])	VC	A,W
18	Red Pierrot	<i>Talicauda nyseus</i> (Guérin-Méneville, 1843)	C	S,M,A,W
19	Gram Blue	<i>Euchrysops cnejus</i> (Fabricius, 1798)	VC	M,A
20	Common Hedge Blue	<i>Acytolepis puspa</i> (Horsfield, [1828])	C	M,A,W
21	Plain Hedge Blue	<i>Celastrina lavendularis</i> (Moore, 1877)	C	S,M,A,W
22	Plains Cupid	<i>Chilades pandava</i> (Horsfield, [1829])	VC	S,M,A,W

Table 4 : Butterflies of Family: Lycaenidae (Blues) recorded at Harkul Khurd village of Sindhudurg district, Maharashtra.

Sr. No.	Common Name	Scientific Name	Relative Abundance	Seasonal Occurrence
1. Family: Nymphalidae (Brush Footed Butterflies)				
Subfamily: Danainae (Milkweed Butterflies)				
01	Blue Tiger	<i>Tirumala limniace</i> (Cramer, [1775])	C	S,M,A,W
02	Striped Tiger	<i>Danaus genutia</i> (Cramer, [1779])	C	S,M,A,W
03	Plain Tiger	<i>Danaus chrysippus</i> (Linnaeus, 1758)	VC	S,M,A,W
04	Glassy Tiger	<i>Parantica aglea</i> (Stoll, [1782])	C	A,W
05	Dark Glassy Tiger	<i>Parantica agleoides</i> (Stoll, [1782])	LC	S,M,A,W
06	Double Branded Crow	<i>Euploea sylvester</i> (Fabricius, 1793)	LC	M,A,W
07	Brown King Crow	<i>Euploea klugii</i> Moore, [1858]	C	M,A
08	Common Crow	<i>Euploea core</i> (Cramer, [1780])	VC	S,M,A,W
Subfamily: Charaxinae (Rajahs, Nawabs, and Begum)				
09	Common Nawab	<i>Charaxes bhārata</i> C. & R. Felder, [1867]	R	S,M,A,W
10	Black Rajah	<i>Charaxes solon</i> (Fabricius, 1793)	R	S,M,A,W
Subfamily: Satyrinae (Browns)				

11	Common Evening Brown	<i>Melanitis leda</i> (Linnaeus, 1758)	C	S,M,A,W
12	Dark Evening Brown	<i>Melanitis phedima</i> (Cramer, [1780])	C	S,M,A,W
13	Common Tree Brown	<i>Lethe rohria</i> (Fabricius, 1787)	VC	M,A
14	Common Palmfly	<i>Elymnias hypermnestra</i> (Linnaeus, 1763)	C	S,M,A,W
15	Common Bushbrown	<i>Mycalesis perseus</i> (Fabricius, 1775)	C	S,M,A,W
16	Dark Brand Bushbrown	<i>Mycalesis mineus</i> (Linnaeus, 1758)	C	A,W
17	Long Brand Bushbrown	<i>Mycalesis visala</i> Moore, [1858]	LC	A,W
18	Nigger	<i>Orsotriaena medus</i> (Fabricius, 1775)	R	A
19	Common Fivering	<i>Ypthima baldus</i> (Fabricius, 1775)	C	S,M,A,W
20	Common Fourring	<i>Ypthima huebneri</i> Kirby, 1871	C	S,M,A,W
Subfamily: Heliconinae (Costers)				
21	Tawny Coster	<i>Acraea terpsicore</i> (Linnaeus, 1758)	R	S,M,A,W
22	Rustic	<i>Cupha erymanthis</i> (Drury, [1773])	LC	A,W
23	Small Leopard	<i>Phalanta alcippe</i> (Stoll, [1782])	VC	W
24	Common Leopard	<i>Phalanta phalantha</i> (Drury, [1773])	VC	S,M,A,W
Subfamily: Limenitinae (Barons, Sailers and Others)				
25	Commander	<i>Moduza procris</i> (Cramer, [1777])	VC	S,M,A,W
26	Small Yellow Sailer	<i>Neptis miah</i> Moore, [1858]	R	M,A,W
27	Common Sailer	<i>Neptis hylas</i> (Linnaeus, 1758)	C	S,M,A,W
28	Yellow Sailer	<i>Neptis ananta</i> Moore, [1858]	VC	A,W
29	Common Baron	<i>Euthalia aconthea</i> (Cramer, [1777])	VC	S,M,A,W
30	Gaudy Baron	<i>Euthalia lubentina</i> (Cramer, [1777])	LC	A,W
31	Baronet	<i>Symphaedra nais</i> (Forster, 1771)	VC	S,M,A,W
32	Grey Count	<i>Tanaecia lepidea</i> (Butler, 1868)	R	S,M,A,W
Subfamily: Biblidinae				
33	Common Castor	<i>Ariadne merione</i> (Cramer, [1777])	VC	S,M,A,W
Subfamily: Nymphalinae (Painted Lady, Pansies, Eggflies, Oakleafs and Others)				
34	Blue Pansy	<i>Junonia orithya</i> (Linnaeus, 1758)	LC	S,M,A,W
35	Yellow Pansy	<i>Junonia hierta</i> (Fabricius, 1798)	LC	S,M,A,W
36	Grey Pansy	<i>Junonia atlites</i> (Linnaeus, 1763)	C	S,M,A,W
37	Peacock Pansy	<i>Junonia almana</i> (Linnaeus, 1758)	C	S,M,A,W
38	Lemon Pansy	<i>Junonia lemonias</i> (Linnaeus, 1758)	VC	S,M,A,W
39	Chocolate Pansy	<i>Junonia iphita</i> (Linnaeus, 1758)	VC	S,M,A,W
40	Great eggfly	<i>Hypolimnas bolina</i> (Linnaeus, 1758)	C	S,M,A,W
41	Danaid Eggfly	<i>Hypolimnas misippus</i> (Linnaeus, 1764)	C	S,M,A,W
42	Orange Oakleaf	<i>Kallima inachus</i> (Doyère, [1840])	LC	S,M,A,W
43	Blue Oakleaf	<i>Kallima horsfieldii</i> (Kollar, [1844])	VR	S,M,A,W

Table 5 : Butterflies of Family: Nymphalidae (Brush Footed Butterflies) recorded at Harkul Khurd village of Sindhudurg district, Maharashtra.

Sr. No.	Common Name	Scientific Name	Relative Abundance	Seasonal Occurrence
Family: Riodinidae (Metalmarks)				
Subfamily: Riodininae (Judies)				
01	Plum Judy	<i>Abisara echerius</i> (Stoll, [1790])	C	S,M,A,W

Table 6 : Butterflies of Family: Riodininae (Metalmarks) recorded at Harkul Khurd village of Sindhudurg district, Maharashtra.

VR=Very Rare, R= Rare, LC= Less Common, C=Common, VC=Very Common
Seasons Occurrence – S = Summer, M = Monsoon, A = Autumn, W = Winter

Sr.No.	Family	VR	R	LC	C	VC	Total
01	Hesperiidae	07	04	05	07	00	23
02	Papilionidae	01	01	04	07	02	15
03	Pieridae	01	01	02	06	07	17
04	Lycaenidae	02	01	01	08	10	22
05	Nymphalidae	01	06	08	16	12	43
06	Riodinidae	00	00	00	01	00	01
Total		12	13	20	45	31	121

Table 7: Relative abundance of butterflies observed at Harkul Khurd village of Sindhudurg district, Maharashtra, India.

VR=Very Rare, R= Rare, LC= Less Common, C=Common, VC=Very Common

ACKNOWLEDGEMENT:

The authors are thankful to the Director of the Institute of Science for the constant support and motivation to carry out this study in the surrounding areas of Harkul-khurd village in Sindhudurg district of Maharashtra, India. Special thanks to the local people of Harkul Khurd village for their gracious help and kind cooperation throughout the field study.

REFERENCES:

1. Acharya, B.K. and Vijayan, L. 2015. Butterfly diversity along the elevation gradient of Eastern Himalaya, India. *Ecological Research* 30: 909-919. <https://doi.org/10.1007/s11284-015-1292-0>
2. Ansari, N.A., Ram, J. and Nawab, A. 2015. Structure and composition of butterfly (Lepidoptera: Rhopalocera) fauna in Surajpur wetland, National Capital Region, India. *Asian Journal of Conservation Biology* 4(1): 43-53.
3. Anto, M., Binoy, C.F. & Anto, I. Endemism-based butterfly conservation: insights from a study in Southern Western Ghats, India. *JoBAZ* 82, 22 (2021). <https://doi.org/10.1186/s41936-021-00221-2>
4. Arya, M.K., Dayakrishna and Verma, A. 2020a. Patterns in distribution of butterfly assemblages at different habitats of Corbett Tiger Reserve, Northern India. *Tropical Ecology* 61(2): 180- 186. <https://doi.org/10.1007/s42965-020-00077-7>
5. Aschehoug, E., Sivakoff, F., Cayton, H., Morris, W. and Haddad, N. 2015. Habitat restoration affects immature stages of a wetland butterfly through indirect effects on predation. *Ecology* 96(7): 1761-1767. <http://www.jstor.org/stable/43494927>
6. Barbier, E.B. 2007. Valuing ecosystem services as productive inputs. *Economic Policy* 22: 178-229. <https://doi.org/10.1111/j.1468-0327.2007.00174.x>
7. Bhardwaj, M. and Uniyal, V.P. 2009. Assessment of butterflies in a montane temperate forest of Allain-Duhaingan catchment in Kullu, Himachal Pradesh, India - proposed hydroelectric project site. *Indian Forester* 135(10): 1357-1365.
8. Bhardwaj, M., Uniyal, V.P., Sanyal, A.K. and Singh, A.P., 2012. Butterflies communities along an elevational gradient in the Tons valley, Western Himalayas: implications of rapid assessment for insect conservation. *Journal of Asia-Pacific Entomology* 15: 207-217. <https://doi.org/10.1016/j.aspen.2011.12.003>
9. Bhaskaran, S. & Eswaran, R., (2005). Status and distribution of butterfly species in Sivakasi Taluk, Tamilnadu. *Journal of Insect science* 18(1): 134-136.
10. Bhowmik, S. and Chowdhury, S.D., 2021. Butterflies (Lepidoptera: Rhopalocera) in and around the Unakoti Archaeological Site with 59 new additions to the butterfly fauna of Tripura, Northeastern India. *Asian Journal of Conservation Biology* 10(1): 68-95.
11. Bohra, S.C. and Purkayastha, J., 2021. An insight into the butterfly (Lepidoptera) diversity of an urban landscape: Guwahati, Assam, India. *Journal of Threatened Taxa* 13(2): 17741-1775. <https://doi.org/10.11609/jott.6122.13.2.17741-17752>
12. Bonebrake, T.C., Ponisio, L.C., Boggs, C.L. and Ehrlich, P.R., 2010. More than just indicators: a review of tropical butterfly ecology and conservation. *Biological Conservation* 143(8): 1831-1841. <https://doi.org/10.1016/j.biocon.2010.04.044>

13. **Borang, A., Bhatt, B.B., Tamuk, M., Borkotoki, A. and Kalita, J.,** 2008. Butterflies of Dihang Dibang Biosphere Reserve of Arunachal Pradesh, Eastern Himalayas, India. *Bulletin of Arunachal Forest Research* 24(1&2): 41-53.
14. **Cabette, R.S.H., Souza, R.J., Shimano, Y. and Juen, L.,** 2017. Effects of changes in the riparian forest on the butterfly community (Insecta: Lepidoptera) in Cerrado areas. *Revista Brasileira de Entomologia* 61: 43-50. <https://doi.org/10.1016/j.rbe.2016.10.004>
15. **Champion, H.G. and Seth, S.K.,** 1968. A revised forest types of India. Manager of Publications, Government of India, Delhi. **Chettri, N.** 2015. Distribution of butterflies along a trekking corridor in the Kangchendzonga Biosphere Reserve, Sikkim, Eastern Himalaya. *Conservation Science* 3: 1-10.
16. **Chettri, P.K., Sharma, K., Dewan, S. and Acharya, B.K.,** 2018. Butterfly diversity in human-modified ecosystems of southern Sikkim, the eastern Himalaya, India. *Journal of Threatened Taxa* 10(5): 11551-11565. <https://doi.org/10.11609/jott.3641>. 10.5.11551-11565
17. **Clark, P.J., Reed J.M. & Chew F.S.,** (2007). Effects of urbanization on butterfly species richness, guild structure, and rarity. *Urban Ecosystems* 10(3): 321–37. <https://doi.org/10.1007/s11252-007-0029-4>
18. **Davidson, N.C.,** 2014. How much wetland has the world lost? Long-term and recent trends in global wetland area. *Marine and Freshwater Research* 65 (10): 936-941. <https://doi.org/10.1071/MF14173>
19. **Dewan, S., Chettri, I.K., Sharma, K. and Acharya, B.K.,** 2019. Kitam Bird Sanctuary, the only low elevation protected area of Sikkim: A conservation hotspot for butterflies in the Eastern Himalaya. *Journal of Asia-Pacific Entomology* 22(2): 575- 583. <https://doi.org/10.1016/j.aspen.2019.04.002>
20. **Dirzo, R., Young, H.S., Galetti, M., Ceballos, G., Isaac, N.J.B. and Collen, B.,** 2014. Defaunation in the Anthropocene. *Science* 345: 401-406. <https://doi.org/10.1126/science.1251817>
21. **Evans, W.H.,** 1932. The Identification of Indian Butterflies. Bombay Natural History Society, Bombay.
22. **Gogoi, M.J.,** 2012. Butterflies (Lepidoptera) of Dibang Valley, Mishmi Hills, Arunachal Pradesh, India. *Journal of Threatened Taxa* 4(12): 3137-3160. <https://doi.org/10.11609/JoTT.o2975.3137-60>
23. **Gogoi, M.J.,** 2013. A preliminary checklist of butterflies recorded from Jeypore-Dehing forest, eastern Assam, India. *Journal of Threatened Taxa* 5(2): 3684-3696. <https://doi.org/10.11609/JoTT.o3022.3684-96>
24. **Gotelli, N.J. and Colwell, R.K.,** 2001. Quantifying biodiversity: procedure and pitfalls in the measurement and comparison of species richness. *Ecology Letters* 4: 379-391. <https://doi.org/10.1046/j.1461-0248.2001.00230.x>
25. **Hill, J.K.,** 1999. Butterfly spatial distribution and habitat requirements in a tropical forest: impacts of selective logging. *Journal of Applied Ecology* 36: 564–572. <https://doi.org/10.1046/j.1365-2664.1999.00424.x>
26. **Joshi, P.C.,** 2007. Community structure and habitat selection of butterflies in Rajaji National Park, a moist deciduous forest in Uttaranchal, India. *Tropical Ecology* 48(1): 119-123.
27. **Joshi, P.C. and Arya, M.,** 2007. Butterfly communities along altitudinal gradients in a protected forest in the Western Himalayas, India. *The Natural History Journal of Chulalongkorn University* 7(1): 1- 9.
28. **Kehimkar, I.,** 2016. The Book of Indian Butterflies. Bombay Natural History Society, Oxford University Press, Mumbai.
29. **Kocher, S.D. and Williams, E.H.,** 2000. The diversity and abundance of North American butterflies, vary with habitat disturbances and geography. *Journal of Biogeography* 27: 785-794. <https://doi.org/10.1046/j.1365-2699.2000.00454.x>
30. **Koh, L.P. & N.S. Sodhi,** (2004). Importance of reserves, fragments, and parks for butterfly conservation in a tropical urban landscape. *Ecological Applications* 14(6): 1695–708. <https://doi.org/10.1890/03-5269>
31. **Konwar, A. and Bortamuly, M.,** 2021. Observations on butterflies of non-protected areas of Titabar, Assam, India. *Journal of Threatened Taxa* 13(5): 18364-18377. <https://doi.org/10.11609/jott.4126.13.5.18364-18377>
32. **Kocher, S.D., & Williams, E.H.,** 2000. The diversity and abundance of North American butterflies vary with habitat disturbance and geography. *Journal of Biogeography* 27(4): 785–94. <https://doi.org/10.1046/j.1365-2699.2000.00454.x>
33. **Kulkarni, M., Ghadi A. and Rangnekar S.,** 2022. Eco-contributory species composition of butterflies in Panchavati garden area, Aarey colony, Goregaon, Maharashtra, India. *Asian Journal of Conservation Biology*, July 2022. Vol. 11 No. 1, pp. 99–105. 10.53562/ajcb.73425
34. **Kunte, K.,** 1997. Seasonal patterns in butterfly abundance and species diversity in four tropical habitats in northern Western Ghats. *Journal of BioSciences* 22(5): 593-603. <https://doi.org/10.1007/BF02703397>
35. **Kunte, K., Sondhi, S., Sangma, B.S., Lovalekar, R., Tokekar, K. and Agavekar, G.,** 2012. Butterflies of the Garo Hills of Meghalaya, northeastern India: their diversity and conservation. *Journal of Threatened Taxa* 4(10): 2933-2992. <https://doi.org/10.11609/JoTT.o2945.2933-92>
36. **Magurran, A.E.,** 2004. Measuring Biological Diversity. Blackwell Publishing Company.

37. **Mathew, G. and Anto, M.**, 2007. In-situ conservation of butterflies through establishment of Butterfly Gardens: a case study at Peechi, Kerala, India. *Current Science* 93(3): 337-347.
38. **Mehta, H.S., Thakur, M.S., Sharma, R.M. and Mattu, V.K.**, 2002. Butterflies of Pong Dam Wetland, Himachal Pradesh. *Bionotes* 4(2): 37-38.
39. **Mittermeier, R.A., Gil, P.R., Hoffman, M., Pilgrim, J., Brooks, T., Mittermeier, C.G., Lamoreux, J. and da Fonseca, G.A.B.**, 2005. Hotspots revisited: earth's biologically richest and most endangered terrestrial ecoregions. Washington:Conservation International.
40. **Mukherjee, K. and Mondal, A.**, 2020. Butterfly diversity in heterogeneous habitat of Bankura, West Bengal, India. *Journal of Threatened Taxa* 12(8): 15804-15816. <https://doi.org/10.11609/jott.5136.12.8.15804-15816>
41. **Murugesan, M., Arun, P.R. and Prusty, B.A.K.**, 2013. The butterfly community of an urban wetland system-a case study of Oussudu Bird Sanctuary, Puducherry, India. *Journal of Threatened Taxa* 5 (12): 4672-4678. <http://dx.doi.org/10.11609/JoTT.o3056.4672-8>
42. **Nelson, S.M.**, 2007. Butterflies (Papilionoidea and Hesperioidea) as potential ecological indicators of riparian quality in the semi-arid western United States. *Ecological Indicators* 7(2): 469-480. <https://doi.org/10.1016/j.ecolind.2006.05.004>
43. **Thomas, J.A.**, 2005. Monitoring change in the abundance and distribution of insects using butterflies and other indicator groups. *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 360(1454): 339-57. <https://doi.org/10.1098/rstb.2004.1585>
44. **Padhye, A.D., Dahanukar, N., Paingankar, M., Deshpande, M. and Deshpande, D.**, 2006. Season and landscape wise distribution of butterflies in Tamhini, north-western Ghats. India. *Zoos' Print Journal* 21(3): 2175-2181. <http://dx.doi.org/10.11609/JoTT.ZPJ.1142.2175-81>
45. **Pahari, P.R., Mishra, N.P., Sahoo, A. and Bhattacharya, T.**, (2018). A study on the butterfly diversity of Haldia industrial belt and adjacent rural area in Purba Medinipur district, West Bengal, India. *World Scientific News*, 97: 207-224.
46. **Pollard, E.**, 1977. A method for assessing changes in the abundance of butterflies. *Biological Conservation* 12(2): 115-134. [https://doi.org/10.1016/0006-3207\(77\)90065-9](https://doi.org/10.1016/0006-3207(77)90065-9)
47. **Pollard, E. and Yates, T.J.**, 1993. *Monitoring Butterflies for Ecology and Conservation*. Chapman and Hall, London. Polunin, O. and Stainton, A. 2005. *Flowers of the Himalaya*. Seventh Impression. Oxford University Press, New Delhi.
48. **Sengupta, P., Banerjee, K.K. and Ghorai N.**, 2014. Seasonal diversity of butterflies and their larval food plants in the surroundings of upper Neora Valley National Park, a sub-tropical broad leaved hill forest in the eastern Himalayan landscape, West Bengal, India. *Journal of Threatened Taxa* 6(1): 5327-5342. <http://dx.doi.org/10.11609/JoTT.o3446.5327-42>
49. **Sharma, K., Acharya, B.K., Sharma, G., Valente, D., Pasimeni, M., Petrosillo, I. and Selvan, T.**, 2020. Land use effect on butterfly alpha and beta diversity in the Eastern Himalaya, India. *Ecological Indicators* 110: 105605. <https://doi.org/10.1016/j.ecolind.2019.105605>
50. **Singh, A.P.**, 2009. Butterflies of Kedarnath Musk Deer Reserve, Garhwal Himalayas, India. *Journal of Threatened Taxa* 1(1): 37-48. <https://doi.org/10.11609/joTT.o1873.37-48>
51. **Singh, A.P. and Bhandari, R.S.**, 2006. New additions to the butterflies of Dehradun Valley, the lower Western Himalayas. *Indian Forester* 132(6): 767-769.
52. **Sondhi, S. and Kunte, K.**, 2018. *Butterflies of Uttarakhand- A Field Guide*. Titli Trust (Dehradun) National Centre for Biological Sciences, Bengaluru. Sondhi, S., Valappil, B., Sondhi, Y. and Sondhi, A. 2017. A report on some butterflies (Lepidoptera) from Ladakh in Jammu & Kashmir and Lahaul in Himachal Pradesh, India. *Journal of Threatened Taxa* 9(3): 9971-9987. <https://doi.org/10.11609/jott.3024.9.3.9971-9987>
53. **Sondhi, S., Valappil, B. and Venkatesh, V.**, 2020. A second report on butterflies (Lepidoptera) from Ladakh Union Territory and Lahaul, Himachal Pradesh, India. *Journal of Threatened Taxa* 12 (8): 15817-15827. <https://doi.org/10.11609/jott.5606.12.8.15817-15827>
54. **Subedi, B., Stewart, A., Neupane, B., Ghimire, S. and Adhikari, H.**, 2020. Butterfly species diversity and their floral preferences in the Rupa wetland of Nepal. *Ecology and Evolution* 11: 2086-2099. <https://doi.org/10.1002/ece3.7177>
55. **Tiple, A.D., Deshmukh, V.P. and Dennis, R.L.H.**, 2006. Factors influencing nectar plant resource visits by butterflies on a university campus: implications for conservation. *Nota Lepidopterologica* 28(3/4): 213-224.
56. **Varshney, R.K. & P. Smetacek**, (eds.) (2015). *A Synoptic Catalogue of the Butterflies of India*. Indinov Publishing, New Delhi, 261pp.

57. Wynter-Blyth, M.A., 1957. Butterflies of Indian region. The Bombay Natural History Society, Bombay.

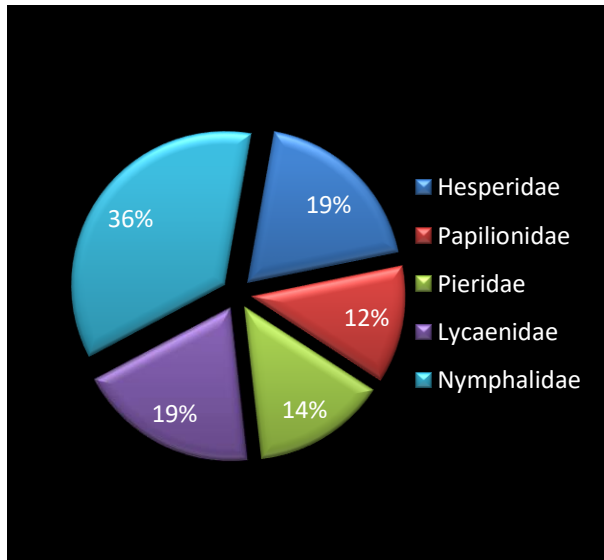


Figure 3. Total species richness and abundance of Butterflies recorded in the study area.

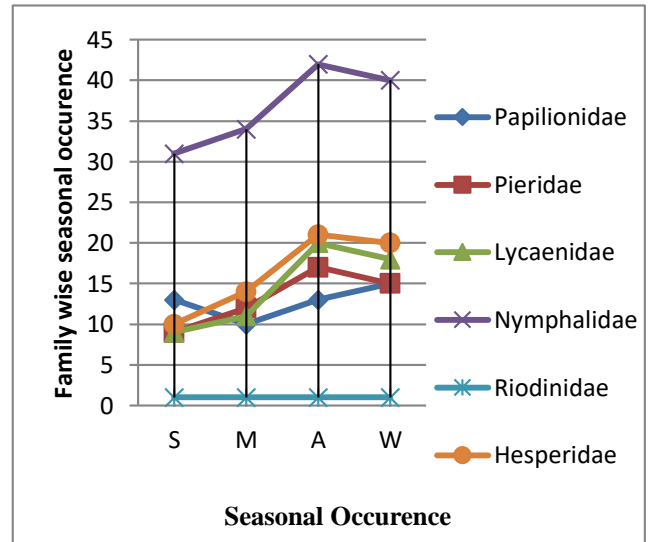


Figure 4. Calculated values of seasonal index for different butterfly families in the study area during 2020-21.





Figure 5. In images of butterflies recorded from the surrounding areas of Harkul-Khurd wetland.

1. *Papilio demoleus*, 2. *Ypthima huebneri* 3. *Orsotriaena medus* 4. *Euploea sylvester* 5. *Tagiades japetus*
6. *Caleta decidia* 7. *Castalius rosimon* 9. *Junonia orithya* 10. *Pareronia hippia* 11. *Acytolepis puspa* 12. *Hebomoia glaucippe*
13. *Neptis hylas* 14. *Jamides celeno* 15. *Abisara echerius* 16. *Kallima horsfieldi* 17. *Cephrenes trichopepla* 18. *Pelopidas mathias mathias*
19. *Loxura atymnus* 20. *Junonia lemonias* 21. *Papilio polytes* 22. *Charaxes solon* 23. *Spindasis vulcanus*
24. *Hypolimnas bolina* 25. *Catopsilia pomona* 26. *Cepora nerissa* 27. *Eurema hecabe* 28. *Moduza procris*

