

BUTTERFLY FAUNA OF TADOBA ANDHARI TIGER RESERVE, CHANDRAPUR DISTRICT, CENTRAL INDIA

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Abstract

Butterfly fauna assessment was carried out in the Tadoba Andhari Tiger Reserve of Chandrapur district, central India. The field investigations carried out in 2019-2020 revealed 66 species of butterfly fauna from five families. The Nymphalidae was the richest family (n=25, 38%) followed by Lycaenidae (n=15, 23%), Pieridae (n=11, 17%), Papilionidae (n=8, 12%) and Hesperidae with the lowest number of species (n=7, 10%). The abundance status of butterflies revealed, 12 (18%) species are very common, 42 (64%) common, and 12 (18%) are rare. Maximum (n=5, 42%) rare species belongs to the Lycaenidae family. The IUCN status of the butterflies revealed eight (12%) are the least concern and 58 (88%) are not evaluated. Three butterfly species are legally protected and included in the Schedules of the Indian Wildlife (Protection) Act, 1972. The results provide an inside into butterfly fauna of a protected area (tiger reserve). This will help the academicians to understand the forest ecosystems contribution for the same and in future to ascertain if any forest cover loss due to anthropogenic activities (forest fires) results into butterfly fauna loss from the study area.

Key Words: *Butterfly diversity, Chandrapur, Lepidoptera, Tadoba Andhari Tiger Reserve*

Introduction

Butterflies make up a large group of insects the order Lepidoptera in the phylum Arthropod. The name from the Greek lepidō “scale” and ptera “wings” refers to prominent features of adult butterflies (the tiny scales that cover the wings). They are also a good indicator of habitat and climate change. Butterflies are wonderfully diverse in shape, size and colour. They are found everywhere around the world except near the Poles. There are about 200,000 known species of Lepidoptera, of which about 10% are butterflies. They are classified into five families viz. the Pieridae, commonly

known as whites and yellows; the Papilionidae, or swallowtails; the Nymphalidae, including the morphs, the owl butterfly and the long wings; the Hesperidae, or skippers; and the small Lycaenidae. Butterflies play an important role as plant pollinators in the food chain as herbivores in the ecosystem. In addition to their ecological niche, butterflies are also a food source to predators like birds, spiders, lizards, and other animals (Gaikwad *et al.*, 2015).

Researchers have used butterflies as model organism to study climate change as well as habitat loss and destruction. They

are also used for the investigation of various areas in biological research such as genetic, evolution, embryology, navigation, pest control, and biodiversity conservation, and population dynamics. However, they have largely been ignored by conservation biologists and policymakers as well. There is a great need for butterflies' species protection which can aid in the cycle of crop production by influencing pollination, and for this reason, many plants depend entirely on these insects (Anbalagan *et al.*, 2015).

In recent years, mass production of butterflies has faced near extinction events. These pollinators are extremely important in the world's food source. Hence, butterflies play a vital role in the ecosystem and the co-evolutionary relationship between them and plants as well as their lives are interlinked (Ghazanfar *et al.*, 2016). There are currently about 18,000 butterfly species in the world, and India has about 1501 butterfly species that are further divided into different families which constitute 65% of total Indian fauna (Kunte *et al.*, 2017). Indian complex forest ecosystem supports various butterfly species. The Western Ghats hosts about 334 species, out of which 48 are endemic to Nilgiri Biosphere Reserve. About 50% of butterfly species of India are found in the state of Assam (Ashok, 2017).

The number of butterfly species has decreased and endangered since the last few years. Because of the increase in urbanization, globalization and industrialization, pollution, habitat loss, and climate change. Pollution disturbs the catabolic and anabolic processes of butterflies. Green-house gases, acid rain, ozone depletion, and global warming are also causing adverse effects on their life (Hill *et al.*, 2005). An inventory of

butterflies will provide valuable inside into the ecological status of an area. Print and online literature review revealed that no study was carried out on the butterfly fauna of Tadoba Andhari Tiger Reserve (TATR) of Chandrapur district, central India. Thus, this is the identified gap in this subject domain. This study was carried out with objectives to assess the butterfly species, dominance, abundance, and International Union for Conservation of Nature (IUCN) status from the TATR. This study outcome will add a new understanding of butterfly species and their ecological status from this tiger reserve. Furthermore, the initiatives to be carried out at national/state-level policy formulation and mechanism for implementation of the same to enhance the butterfly diversity and pave a way for a sustainable ecosystem.

Study Area

The study was carried out in TATR a wildlife sanctuary in Chandrapur district of central India. It is Maharashtra states oldest and largest national park created in 1955. The reserve includes the Tadoba National Park and the Andhari Wildlife Sanctuary. TATR (Longitude 79°11'50" E to 79°40'54" E and Latitude 19°59'27" N to 20°29'44" N) (Figure 1) has a total area of 1727.17 km². The core area is of 625.4 km² which consists of 577.98 km² (223.15 sq mi) of reserve forest, 32.51 km² (12.55 sq mi) of protected forest and 14.93 km² as other area. Buffer area is 1101.77 sq km with 401.49 km² as other area. It comprises of 91 compartments, which are organized into 3 ranges, 10 rounds, and 34 beats for purpose of administration and management (Tadoba Forest, 2019). Bio-geographically the area is classified as Paleotropical kingdom, Indomalayan sub-kingdom, Deccan peninsular zone and central plateau as biotic province.

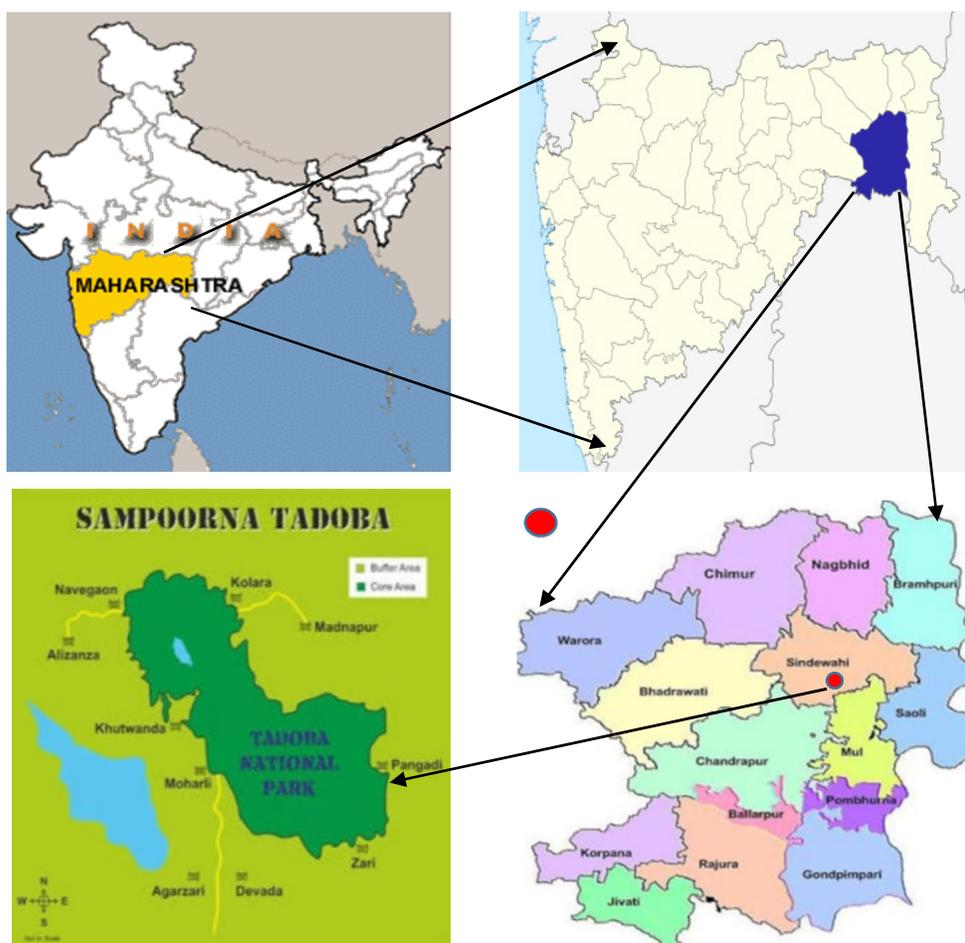


Fig. 1: Tadoba Andhari Tiger Reserve

The climatic condition in the study area during winters which stretches from November to February; daytime temperatures are in the 25°-30°C. In the case of summers from March to June, it is extremely hot with the temperature rising to 47°C. The monsoon season begins in June; the area receives heavy rainfall (approx. 1275 mm per year) and humidity hovers around 66% (Tadoba Forest, 2019).

The forest of the TATR is a tropical dry deciduous forest type with dense woodlands comprising about 87 percent of the protected area. Patches of grasses and bamboo thickets grow throughout the

reserve. Teak is the predominant tree species from the reserve while other plant species include *Diosyros melanoxylon*, *Indian frankincense*, *Haldina cordifolia*, *Pterocarpus marsupium*, *Terminalia arjuna*, *Terminalia elliptica*, *Anogeissus latifolia* etc. Bamboo (*Dendrocalamus strictus*) is spread over 40% of the habitat. There are 667 species of flowering plants. Besides, it houses carnivores like tigers, leopards, wild dogs, herbivores like bison, cheetal, Asiatic antelope, barking deer, bear, wild boar, a group of avifauna, insects etc. As of 2018 TATR has about 86 tigers. As many as, 280 species of birds are found, apart from reptiles (54 species),

amphibians (11 species) and fishes (84 species) (Tadoba Forest, 2019).

Methodology

The field investigations were carried out during winter, summer, and post-monsoon of the year 2019 and 2020. Butterflies were studied in the morning time by random observations in the selected sites based on habitats present. For observation Pollard Walk method (Pollard, 1977 and Pollard and Yates, 1993) was followed for observing butterflies that is walking along the fixed paths while recording these species. In the field, photographs of the butterflies were taken with the aid of a camera for identification purposes. Colour patterns, sizes, and shapes as well as their designs were considered for the identification purpose along with the help of an entomologist expert and relevant available literature.

The dominant butterfly family from the study area was identified based on the maximum number of species belonging to it. Abundance assessment was attempted based on their presence by categorizing the butterfly species into three groups viz. very common, common, and rare. Furthermore, the IUCN status of each species was assessed based on the existing literature where the butterfly species are

divided into nine categories ranging from not evaluated to extinct.

The butterflies were identified by using field guides (Gunathilagaraj *et al.*, 1998) and Butterflies of Western Ghats (Kunte, 1997). Standard guides and references which are available (Kunte, 2000) aided identification, classification and nomenclature of butterflies. Data analysis was carried out on the basis of relative abundance of the butterfly species in three different categories as very common, common and rare. Accordingly, those species observed 80-100% of the survey days are categorized as very common, 40-80% as common and 20-40% as rare. Dominant species of butterfly was derived at with the family having maximum number of species. IUCN status of the species was attempted on the basis of their existing status.

Results and Discussion

The inventory of the butterfly species recorded from the study area is presented in Table 1. The result shows that 66 butterfly species belonging to five families were recorded from TATR. Nymphalidae was the richest butterfly family with 25 (38%) species followed by Lycaenidae 15 (23%), Pieridae 11 (17%), Papilionidae 8 (12%), and Hesperidae with a minimum 7 (10%) species.

Table 1: Inventory of butterfly species from Tadoba Andhari Tiger Reserve

Scientific name	Common name	Vernacular name (Marathi)	Relative abundance
Family-Nymphalidae			
<i>Euthalia nais</i>	Baronet	Zingori	C
<i>Charaxes solon</i>	Black Rajah	Krushna naresh	C
<i>Junonia orithya</i>	Blue Pansy	Nil bhirabhairi	R
<i>Tirumala limniace</i>	Blue Tiger	Nil ruikar	V
<i>Junonia iphita</i>	Chocolate Pansy	Tapakiri bhirabhiri	C
<i>Moduza procris</i>	Commander	Nayak	C
<i>Euthalia aconthea</i>	Common Baron	Sardar	C
<i>Mycalesis perseus</i>	Common Bushbrown	Chhaya	C
<i>Euploea core</i>	Common Crow	Habashi	V
<i>Melanitis leda</i>	Common Evening Brown	Sanjapari	V
<i>Phalanta phalantha</i>	Common Leopard	Bitti	V
<i>Charaxes athamas</i>	Common Nawab	Nawab	C
<i>Neptis hylas</i>	Common Sailer	Tarang	C
<i>Hypolimnas misippus</i>	Danaid Eggfly	Chhota chandava	C
<i>Hypolimnas bolina</i>	Great Eggfly	Motha chandava	C
<i>Junonia atlites</i>	Grey Pansy	Rakhi bhirabhiri	R
<i>Junonia lemonias</i>	Lemon Pansy	Pittaneri bhirabhiri	C
<i>Junonia almanac</i>	Peacock Pansy	Mayur bhirabhiri	C
<i>Danaus chrysippus</i>	Plain Tiger	Ruikar	V
<i>Neptis columella</i>	Short Banded Sailer	Laghu patta tarang	C
<i>Athyma selenophora</i>	Staff Sergeant	Patta rakshak	C
<i>Danaus genutia</i>	Striped Tiger	Patteri ruikar	C
<i>Acraea terpsicore</i>	Twany Coaster	Krushnakamalini	C
<i>Charaxes bernardus</i>	Tawny Rajah	Tapakiri naresh	R
<i>Junonia hierta</i>	Yellow Pansy	Pitta bhirabhiri	V
Family-Lycaenidae			
<i>Caleta caleta</i>	Angled Pierrot	Koneri Kavada	C
<i>Acytolepis puspa</i>	Common Hedge Blue	Nilayam	C
<i>Prosotas nora</i>	Common Line Blue	Nilarekha	R
<i>Castlius rosimon</i>	Common Pierrot	Kavada	C
<i>Spindasis vulcanus</i>	Common Silverline	Ruparekha	C
<i>Catochrysops strabo</i>	Forget-Me-Not	Avismaraniya	R
<i>Euchrysops cnejus</i>	Gram Blue	Nilaya	V
<i>Everes lactunus</i>	Indian Cupid	Pandav	R
<i>Chilades lajus</i>	Lime Blue	Nilimba	C
<i>Lampides boeticus</i>	Pea Blue	Nilavatana	V
<i>Anthene lycaenina</i>	Pointed Ciliate Blue	Tokeri nilaksha	C
<i>Tarucus extricates</i>	Rounded Pierrot	Patteri kavada	R
<i>Prosotas dubiosa</i>	Tailless Line Blue	Bhundi nilarekha	R
<i>Zizula hylax</i>	Tiny Grass Blue	Chingi	C
<i>Leptotes plinius</i>	Zebra Blue	Pattanila	C
Family-Pieridae			
<i>Catopsilia pomona</i>	Common Emigrant	Pardeshi/ Bhatakya	C
<i>Eurema hecabe</i>	Common Grass Yellow	Trun pilati	V
<i>Cepora nerissa</i>	Common Gull	Kavadasha	C

<i>Delias eucharis</i>	Common Jezebel	Haldikunku	C
<i>Pareronia valeria</i>	Common Wanderer	Vimukta	C
<i>Colotis fausta</i>	Large Salmon Arab	Motha pillupriya	C
<i>Belenois aurota</i>	Pioneer	Gaurang	C
<i>Eurema brigitta</i>	Small Grass Yellow	Laghu trun pilati	C
<i>Anthocharis cadamines</i>	Small Orange Tip	Chhotya shendurtokya	C
<i>Eurema laeta</i>	Spotless Grass Yellow	Niranka trun pilati	C
<i>Ixias marianne</i>	White Orange Tip	Pandhara shendurtokya	C
Family-Papilionidae			
<i>Papilio crino</i>	Common Banded Peacock	Patta mayur	R
<i>Papilio clytia</i>	Common Mime	Songadya	R
<i>Papilio polytes</i>	Common Mormon	Bahurupi	V
<i>Pachliopta aristolochiae</i>	Common Rose	Gulabi rani/ madalasha	V
<i>Pachliopta hector</i>	Crimson Rose	Kiramiji madalasha	C
<i>Papilio demoleus</i>	Lime Butterfly	Limbali	V
<i>Graphium nomius</i>	Spot Swordtail	Talwarpuchha	C
<i>Graphium agamemnon</i>	Tailed Jay	Chashpakoli/Ashokatka	C
Family-Hesperiidae			
<i>Badamia exclamationis</i>	Brown Awl	Tapkiti arl/ Sutari	C
<i>Hasora chromus</i>	Common Banded Awl	Natteri sutari	C
<i>Pelopidas conjuncta</i>	Conjoined Swift	Susangat tadatadya	R
<i>Telicota ancilla</i>	Dark Palm Dart	Gadad shar	R
<i>Spialia galba</i>	Indian Skipper	Sairat	C
<i>Borbo cinnara</i>	Rice Swift	Dhan tadatadya	C
<i>Pelopidas mathias</i>	Small Branded Swift	Lahan tadatadya	C

V- Very common, C- Common, and R- Rare

Dominance

In each community, all the species are not equally important. There are relatively only a few of these, which determine the nature of the community, such species are known as dominants. These few species exert a major controlling influence on the community. The dominants in a community may be the most numerous, possess the highest biomass, pre-empt the most space, make the largest contribution to energy flow or nutrient cycling, or by some other means control or influence the rest of the community. The large numbers of species have a great influence on the community as compared to other species that know as territory of specific species. During the study, it was found that Nymphalidae commonly known as the

Brush-footed butterflies with 25 species was the dominating butterfly family followed by Lycaenidae (15), Pieridae (11), Papilionidae (8), and the least number of species was observed in Hesperiidae (7) (Table 2).

Table 2: Dominant butterfly species

Family	Species
Nymphalidae: Brush-footed butterflies	25
Lycaenidae: Blues	15
Pieridae: White and Yellows	11
Papilionidae: Swallowtails	08
Hesperiidae: Skippers	07
5	66

Abundance

To assess the abundance of the butterfly species recorded from the study

area they are categorized into three groups viz. very common 12 (18%), common 42 (64%), and rare 12 (18%) (Table 3). Of the five butterfly families, maximum (n=5, 42%) rare category butterfly species are recorded from Lycaenidae followed by Nymphalidae (n=3, 25%) and minimum (n=2, 16.7%) from Hesperidae and Papilionidae. Indian Wildlife (Protection) Act, 1972 protects 452 species of butterflies in three schedules. From the study area *Hypolimnas misippus* and *Hypolimnas bolina* species are included in Schedule II Part II, while *Delias eucharis* is included in Schedule I Part IV of the act. Maximum butterfly species diversity was observed from June to September and October to January. June to September period coincides with the monsoon season and October to January is the winter season. During these seasons growth of new host plants followed by flowering results in the availability of nectar which serves as a source of food for these butterflies. As butterflies can't survive in very cold weather conditions their abundance gets reduced from January onwards.

Table 3: Abundance of butterfly species

Status	No. of species	% of species
Very common	12	18
Common	42	64
Rare	12	18
	66	100

IUCN Status

The IUCN status is one of the most well-known objective assessment systems for classifying the status of organisms. It divides species into nine categories ranging from not evaluated to extinct. Based on the IUCN status, butterfly species are divided into two categories viz. least concern and not evaluated. Of

the total number of butterflies (n=66), eight (12%) are least concern and 58 (88%) are not evaluated. These not evaluated butterfly species needs to be assessed to classify them accordingly and further to take appropriate steps for their protection and conservation.

The diversity and abundance of butterflies correlate with the flowering phenology of plants (Gutierrez and Menendez (1995); Kunte, 2000; Watt *et al.*, 1974). Crimson rose was highly abundant from June to August. Blue tiger emerged in the rainy season during October was the period of peak emergence of adults. Common crow larva emerged in adults from March to April. The Tawny coaster was the maximum occurrence during May and September. Butterfly species from Papilionidae family was found in June to August.

Khan *et al.* (2007) reported 16 species from Kotli, 20 species from Mirpur, and 19 species from Bhimber, Azad Kashmir belonging to seven families and 30 genera. None of the species reported to be threatened to become extinct nor any species reported being favoured by enriched flora. Emmel and Larsen (1997) reported 450 species of butterflies from Ghana, West Africa. Islam *et al.* (2011) identified 158 species belonging to 10 families, 87 species of which are newly-recorded. Hasanah *et al.* (2006) found that 1825 individuals belonging to 185 species at Bukit Barisan Selatan National Park, Sumatera, Indonesia. Tiple *et al.* (2006) reported 48 butterfly species belonging to five families and included five species previously unrecorded in the Amravati University campus. From the study area, 66 butterfly species from five families are recorded.

Martinez *et al.* (2003) reported around 1800 butterfly species from Mexico.

About 14.8% butterfly species and six genera appear to be endemic to Mexico. Molleman *et al.*, (2004) caught 32,308 individuals of 94 butterfly species in the understory and canopy of Kibale Forest, Uganda. About 14% of these species could be categorized as canopy specialists and 68% as understory specialists. Of the identified butterfly species from the study area, 12 (18%) are very common, 42 (64%) common, and 12 (18%) rare.

Tabadepu *et al.* (2008) recorded 237 individuals belonging to 26 species and four families in and around Salak Mountain, Indonesia. Nymphalidae was the most abundant and species-rich family. The lowest number of individuals and species was recorded from Papilionidae with only two singleton species (*Graphium evemon* and *Papilio demolion*). *Melanitis leda* was the species frequently found. Van and Van (2011) recorded 112 species with 1703 individuals of Papilionidae (except Lycaenidae) of a tropical rain forest of Bu Gia Map National Park in South Vietnam. Anbalagan *et al.* (2015) reported 4,644 individuals of 101 species. A member belonging to the Nymphalidae and Hesperidae was the most common with the 53 species being recorded accounting for 28.71% and 23.76% of the total number of individuals collected. In the Phaltan region, as many as 37 butterfly species belonging to 26 genera and six families were recorded. Among these families, Lycaenidae was the most dominant family represented by 13 species followed by Nymphalidae with seven species, and Hesperidae with six species (Gaikwad *et al.*, 2015). A total of 86 butterfly species occur in and around Nagpur city. The family-wise abundance is Papilionidae (12), Pieridae (15), Lycaenidae (23),

Nymphalidae (39), and Hesperidae (11) (Kasambe and Wadatkar, 2008). Nine hundred and fifty-five individuals of butterflies have recorded from various study sites of Jhansi, which include 38 species belonged to 29 genera and six families. Nymphalidae family was the most dominant with 11 species followed by Pieridae (10), Lycaenidae (6), Danaidae (4), Hesperidae (4), Papilionidae (3) (Ashok, 2017). A total of 96 butterfly species belonging to 68 genera and five families were recorded in Assam University campus and its vicinity, Cachar district, Assam, India of which 13 species were under the rare category including nine rare and four very rare (Bora and Meitei, 2014). The Nymphalidae family represented by 23 genera and 34 species was the most dominant followed by Lycaenidae (19 genera, 20 species), Hesperidae (13 genera, 15 species), Pieridae (9 genera, 14 species), and Papilionidae (4 genera, 13 species). From the study area, 66 butterfly species from five families are recorded. The families are in the order of Nymphalidae > Lycaenidae > Pieridae > Papilionidae > Hesperidae. The maximum number of species (n=25) are from Nymphalidae whereas, the minimum (n=7) from Hesperidae.

Kunte *et al.* (2012) reported 298 butterfly species for the Garo Hills, eight of which are legally protected under Schedule I and 33 under Schedule II of the Indian Wildlife (Protection) Act, 1972. From the study area, *Hypolimnas misippus* (Danaid egg fly) and *Hypolimnas bolina* (Great egg fly) species were included in Schedule II Part II, while *Delias eucharis* (Common jezebel) in Schedule I Part IV of the act.

Conclusions

The conclusions drawn from the results obtained for this study are as follows:

1. The Nymphalidae was the most common family, followed by the Lycaenidae, Pieridae, Papilionidae, and the least number of species was observed in Hesperidae. Large numbers of species are recorded from five butterfly families.
2. Species diversity and abundance are correlated with environmental factors viz. temperature, precipitation, humidity and host plant phenology.
3. The rare butterfly species needs to provide adequate protection and conservation to maintain the ecosystem balance.
4. Those butterfly species whose IUCN status is not evaluated needs to be carried out with priority.
5. The butterfly fauna indicates ecologically very productive status of TATR forest ecosystem.

References

- Anbalagan, V., Ignacimuthu, S., and Chandran, S. (2015). Diversity of butterflies in different seasons in North-Eastern Tamil Nadu, India. *International Journal of Modern Research and Reviews*, 2(11): 1029-1033.
- Ashok (2017). Species diversity and distribution of butterfly fauna with heterogeneous habitats in Jhansi, India. *International Journal of Advanced Research in Biological Sciences*, 4(7): 104-110.
- Bora, A. and Meitei, L.R. (2014). Diversity of butterflies (Order: Lepidoptera) in Assam university campus and its vicinity, Cachar district, Assam, India. *Journal of Biodiversity and Environmental Sciences*, 5(3): 328-339.
- Emmel, T. and Larsen, T. (1997). Butterfly diversity in Ghana, West Africa. *Tropical Lepidoptera*, 8(3): 1-13.
- Gaikwad, A.R., Shende, S.S. and Kamble, K.S. (2015). Survey of butterfly species diversity and abundance in Phaltan region, district Satara, Maharashtra. *Journal of Entomology and Zoology Studies*, 3(5): 32-37.
- Ghazanfar, M., Malik, M.F., Hussain, M., Iqbal, R. and Younas, M. (2016). Butterflies and their contribution in ecosystem: A review. *Journal of Entomology and Zoology Studies*, 4(2): 115-118.
- Gunathilagaraj, K., Perumal, T.N.A., Jayaram, K. and Ganesh Kumar, M. (1998). Some Indian Butterflies. Udhagamandalam: Nilgiri Wild Life and Environment Association. pp. 274.
- Gutierrez, D. and Menendez, R. (1995). Distribution and abundance of butterflies in a mountain area in the northern Iberian peninsula. *Ecography*, 18(3): 209-216. doi:10.1111/j.1600-0587.1995.tb00123.x
- Hasanah, N., Tabadepe, H., Sahari, B. and Buchori, D. (2006). Butterfly community structure in Bukit Barisan Selatan National Park, Sumatera. Wildlife Conservation Society. pp. 10-23.
- Hill, D., Fasham, M., Tucker, G., Shewry, M., and Shaw, P. (2005). Biodiversity evaluation methods. In D. Hill, M. Fasham, G. Tucker, M. Shewry, and P. Shaw (eds.), *Handbook of Biodiversity Methods: Survey, Evaluation and Monitoring* (pp. xiii-xiv).

- Cambridge: Cambridge University Press.
- Islam, A., Islam, M., Saifullah, A., Endo, K. and Yamnaka, A. (2011). New records of butterflies and their species diversity in four different areas of Savar, Dhaka, Bangladesh. *Rajshahi University Zoological Society*, 30: 9-15.
- Kasambe, R. and Wadatkhar, J. (2008). Butterfly fauna in and around Nagpur city of Maharashtra. *Indian Lepidoptera*, 4: 3-8.
- Khan, M.R., Rafi, M.A., Munir, M., Hussain, S., Baig, M.W. and Khan, M.W. (2007). Biodiversity of butterflies from districts Kotli, Mirpur and Bhimber, Azad Kashmir. *Pakistan Journal of Zoology*, 39(1): 27-34.
- Kunte, K. (1997). Seasonal patterns in butterfly abundance and species diversity in four tropical habitats in Northern Western Ghats. *Journal of Bioscience*, 2(5): 593-603.
- Kunte, K. (2000). India-a lifescape butterflies of Peninsular India, Hyderabad. Universities Press (India) Private Limited, 1-277.
- Kunte, K., Sondhi, S., Sangma, B.M., 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.
- Kunte, K., Sondhi, S. and Roy, P. (eds.). (2017). Butterflies of India, v. 2.31. Indian Foundation for Butterflies. <http://www.ifoundbutterflies.org/home>.
- Martinez, A., Bousquets, J., Fernandez, I. and Warren, A. (2003). Biodiversity and biogeography of Mexican butterflies. *Proceedings of the Entomological Society of Washington*, 105(1): 209-224.
- Molleman, F., Kop, A., Brakefield, P., Vries, P. and Zwaan, B. (2004). Vertical and temporal patterns of biodiversity of fruit feeding butterflies in a tropical forest in Uganda. *Biodiversity and Conservation*, 15: 107-121.
- Pollard, E. (1977). A method for assessing changes in the abundance of butterflies. *Biological Conservation*, 12: 15-153.
- Pollard, E. and Yates, T.J. (1993). Monitoring butterflies for ecology and conservation. London: Chapman and Hall, London. pp. 274.
- Tabadepu, H., Buchori, D. and Sahari, B. (2008). Butterfly record from Salak Mountain, Indonesia. *Perhimpunan Entomologi Indonesia*, 5(1): 10-16.
- Tadoba Forest, (2019). Available at: <http://www.mahatadobatiger.com/TadobaForest.aspx> (Accessed on February 10, 2019)
- Tiple, A., Deshmukh, V. and Dennis, R. (2006). Factors influencing nectar plant resource visits by butterflies on a university campus: Implications for conservation. *Nota Lepidopterologica*, 28(3/4): 213-224.
- Van, L. and Van, C. (2011). Diversity pattern of butterfly communities (Lepidoptera, Papilionidae) in different habitat types in a tropical rain forest of Southern Vietnam. *International Scholarly Research Network ISRN Zoology*, 2011: 8.
- Watt, W.B., Hoch, P.C. and Mills, S.G. (1974). Nectar source use by *Colias* butterflies chemical and visual aspects. *Oecologia*, (14): 353-374.