



Preliminary studies on butterfly species diversity, relative abundance, and status in adjoining areas of the biggest natural floodplain wetland of Bakhira, Terai, Eastern Uttar Pradesh, India

Jyoti Antil¹, Prashant Tripathi¹, Amita Kanaujia²

¹ Research Scholar, Department of Zoology, University of Lucknow, Lucknow, Uttar Pradesh, India

² Professor, Department of Zoology, University of Lucknow, Lucknow, Uttar Pradesh, India

Abstract

Bakhira, the freshwater marsh located in the Sant Kabir Nagar district, is the largest natural floodplain wetland of eastern Uttar Pradesh, India. Since there is a scarcity of data on bio-resources which are found to be critical to ecological functioning, this study reported the species diversity, relative abundance, local status, and seasonal patterns of butterflies in a wetland environment and adjoining areas of the Bakhira sanctuary for their future conservation and management. A total of 45 species from 33 genera under five butterfly families were documented from the adjoining areas of the wetland and surrounding plantation surveyed from 2023 to 2024. Nymphalidae was the most dominant taxonomic group of butterflies, with 19 species over 42.22% of the total individuals. Species on conservation priority were rare (13.33% species) and legally protected (13.33% species). Seasonal variations, along with overall species diversity richness and relative abundance of butterflies, were noted. Butterfly species showed a high degree of similarity in summer and autumn. The present research study is preliminary to determine the diversity, local status, and seasonal variation of butterflies in the mosaic of vegetation around the Bakhira wetland. The findings highlighted the significance of the diverse vegetation mosaic in supporting a high butterfly diversity around the wetland, emphasizing the need for its management and conservation to preserve the region's ecological health and integrity.

Keywords: Seasonality, butterfly diversity, relative abundance, wetland, baseline study, Bakhira

Introduction

The Ramsar Convention (International Wildfowl Research Bureau, 1971) defines a wetland as an area of marsh or fen, peat land, or water, whether it is artificial or natural, permanent, or temporary, and contains fresh, brackish, or salty water. One of the planet's most prolific ecosystems is thought to be wetlands (Barbier, 2007) [5]. As the wetland ecosystem is formed at the juncture of terrestrial and aquatic habitats, a variety of biota is supported by it, and it provides high conservation value in safeguarding human welfare (Xu et al., 2019) [44]. However, over the years, they are facing gradual depletion, resulting in several problems in urban areas such as water logging, flooding, and water scarcity (Anon, 2011) [1]. The wetland environment is in danger due to the deteriorating condition of wetlands, which is negatively impacting its distinctive and varied biotic composition, including insects (Mensah et al., 2018) [19]. As a result, ground research on bio-resources, such as insect diversity, is crucial for developing effective wetland restoration and conservation policies.

Butterflies (Lepidoptera: Papilionoidea) are the most exquisite and conspicuous than most of the other insects and have been alluring creatures to human imagination and creativity (Sharma and Joshi 2009) [31]. Butterflies are considered one of the most thoroughly studied insect groups in terms of taxonomy (Robbins & Opler 1997) [28]. Due to their complex and vital connections within the food web, they play a crucial role in maintaining biodiversity in natural ecosystems (Bonebrake et al., 2010) [6]. Due to their sensitivity to habitat degradation and climate change, butterflies are also valuable bioindicators of environmental changes (Kunte, 2000) [16, 17]. Recent studies show that the Indian subcontinent harbors about 1,318 species of butterflies (Varshney & Smetacek, 2015) [41]. The diversity

of various plant communities in an area determines the butterfly diversity of the area (Murugesan et al. 2013) [24]. Seasonal factors are also important determinants of the spatiotemporal patterns of butterfly species richness and diversity, in addition to plant communities. (Sharmila et al., 2020) [32]. Seasonal variations in rainfall and temperature also have a significant impact on the diversity and resemblance of resident butterfly communities.

Globally, wetlands are recognized as important wildlife habitats and hubs of rich biodiversity (Xu et al., 2019) [44]. Uttar Pradesh (UP) is endowed with such wetlands in plenty. According to the RSAC's recent report (2009), wetlands make up 1145178 hectares or 4.8% of UP's total land area. The Terai region of Uttar Pradesh is low-lying, marshy terrain and interspersed with various rivers, wetlands, and floodplains. One such wetland is Bakhira, which was declared a bird sanctuary in 1990 by the Forest and Wildlife Department, Uttar Pradesh. Bakhira wetland is a natural wetland in the Terai landscape. It is the largest natural floodplain wetland in eastern Uttar Pradesh. Previous work on the Bakhira wetland has been majorly focussed on avifauna (Mishra et al. 2016 [20]; 2020 [21]; Kumar and Dwivedi, 2022) [3] and slightly on flora (Mishra and Narain, 2010) [22]. There are no published records on the butterfly fauna of Bakhira Wetland. Because of their scientific and ecological importance, butterflies have been widely studied in Uttar Pradesh's protected and non-protected forest environments. Nevertheless, this work is the first-ever scientific study on the diversity, local abundance status, seasonal pattern, and relative abundance, of the butterfly species in the Bakhira wetland. The present study started with the aim of examining and understanding the diversity and abundance of butterfly populations across seasons in the Bakhira wetland.

Material and Methods

Study Site



Eastern Uttar Pradesh's Sant Kabir Nagar district boasts Bakhira Lake (N 26°54' E 83°06'), India's biggest natural floodplain wetland. Established in 1980, this sprawling lake, 44 km west of Gorakhpur, covers an impressive 29 square kilometres. The sanctuary is under the administrative control of Sohagibarwa Wildlife division, Maharajganj.

Figure.1: Map of Bakhira Sanctuary, Sant Kabir Nagar Forest Division, Terai, Eastern Uttar Pradesh (Source: rsis.ramsar.org)

The sanctuary forms India's largest natural floodplain wetland, spanning an area of 28.9421 km². It serves a dual purpose: a crucial winter haven for migratory waterbirds and a breeding ground for resident birds. The Bakhira Canal, connected to the lake, provides irrigation for

surrounding communities for 15 kilometres. The wetland's terrain and landscape are nearly flat, with an average height of 100 meters above mean sea level, which is characteristic of the Terai. Bakhira wetland and its nearby bank have many plants and grasses, which attract different butterflies. A count of 119 species of aquatic and marshy plants was given in a study (Mishra and Narain, 2010) [22]. *Ipomoea aquatica*, *Spirodela*, *Eichhorhia crustipes*, *Vallisneria spiralis*, *Ceratophyllum demersum*, *Nymphoides spp.*, *Elecharis spp.*, *Jussieua repens*, *Hydrilla verticillata*, *Potamageton crispus*, *Naja spp.*, and other aquatic weeds (Johnson et al., 2021) [10] are the commonly found in the lake, some of these plants acts as nectar plants for butterflies and moths.



Fig 2: Bakhira Sanctuary along with its vegetation (Picture source: Jyoti Antil)

Data Collection and identification of butterflies

The results shown here are derived from random surveys conducted between May 2023 and April 2024. The paths

around wetland and plantation patches, along with nearby agricultural fields, were surveyed in the morning from 7 a.m. to 10 a.m. and in the evening from 4 p.m. to 6 p.m.

with the help of a Bushnell binocular (8x40). The survey was carried out bimonthly, on days when the weather was favorable for butterfly activity, which is usually between 18 and 37° C, with partial to full sun and little wind (Whitaker and Long, 2014). Photographs of butterflies were taken with a DSLR Canon 70D. Butterflies were primarily identified directly in the field with the help of field guides based on morphological and behavioral descriptions with reference to Evans (1932) [8], Wynter-Blyth (1957) [43], Kehimkar (2016) [12], and Sondhi and Kunte (2018) [34]. Scientific names used in this study are according to Varshney (1983) [40], and common English names are according to Wynter-Blyth (1957) [43]. Four distinct seasons were divided throughout the year to examine the seasonal patterns, diversity, and relative abundance of butterflies in relation to nectar food plants (Nimbalkar, 2011) [26]. The four seasons are summer from March to May, monsoon from June to August, Autumn from September to November, and winter from December to February. The seasonality was determined using the presence-absence scoring method, and thereafter, the

percentage (%) of occurrence was calculated to determine the local status. Based on their abundance in the study area, the observed butterflies were divided into four groups: VC (very common; > 100 sightings), C (common; 50-100 sightings), O (occasional; 15-50 sightings), and R (rare; 2-15 sightings) (Tiple et al. 2006) [38].

Habitat

Major trees such as Gular (*Ficus glomerata*), Sihor (*Strabulus asper*) *Dalbergia sissoo*, *Ficus sp.*, *Azadirachta indica*, *Mangifera indica*, *Acacia arabica* found far off from the Bakhira lake and aquatic plants such as Narkat (*Phragmites karkua*) (Johnson et al., 2021) [10] are host plants to several butterfly species. Aquatic plants such as *Hygrophila auriculata*, *Hygrophila costata* and *Limnophila heterophylla* growing in the vicinity of water bodies and wetlands are found to be host plants for *Junonia atlites* and *Utricularia hispida* as larval hosts for several other butterflies (Baidya, 2021) [4].



Fig 3: An image of Bakhira wetland located in Terai of Eastern Uttar Prdaesh, India

Observation

Table 1: Checklist of butterflies of Bakhira Sanctuary along with legal status, status, and seasonality.

| Sr. No. | Family/Scientific Name | Common Name | IUCN Status | Legal Status (IWPA,1972) | Seasonal Occurrence | Local Status |
|---------|--|----------------------|-------------|--------------------------|---------------------|--------------|
| A. | Lycaenidae | | | | | |
| 1. | <i>Castalius rosimon</i> (Fabricius) | Common Pierrot | NE | WPA-I | S, W | C |
| 2. | <i>Catochrysops strabo</i> (Fabricius) | Forget-Me-Not | NE | -- | S | R |
| 3. | <i>Cigaritis vulcanus</i> (Fabricius) | Common Silverline | NE | -- | S, A, W | R |
| 4. | <i>Pseudozizeeria maha</i> (Kollar) | Pale Grass Blue | LC | -- | S, A, W | C |
| 5. | <i>Lampides boeticus</i> (Linnaeus) | Pea Blue | LC | WPA-II | S, M, A | VC |
| 6. | <i>Zizula hylax</i> (Fabricius) | Tiny grass blue | LC | -- | S, M, A, W | C |
| 7. | <i>Euchrysops cnejus</i> (Fabricius) | Gram blue | NE | WPA-II | S, M, W | C |
| B. | Nymphalidae | | | | | |
| 8. | <i>Danaus chrysippus</i> (Linnaeus) | Plain Tiger | LC | -- | S, A, W | VC |
| 9. | <i>Danaus genutia</i> (Cramer) | Striped Tiger | NE | -- | S, A, W | VC |
| 10. | <i>Euploea core</i> (Cramer) | Common Crow | LC | -- | S, A, W | VC |
| 11. | <i>Melanitis leda</i> (Linnaeus) | Common Evening Brown | NE | -- | S | R |
| 12. | <i>Phalanta phalantha</i> (Drury) | Common Leopard | NE | -- | M | R |
| 13. | <i>Junonia iphita</i> (Cramer) | Chocolate Pansy | NE | -- | S, M, A, W | C |
| 14. | <i>Junonia orithya</i> (Linnaeus) | Blue Pansy | LC | -- | S, M, A | C |
| 15. | <i>Junonia almanac</i> (Linnaeus) | Peacock Pansy | LC | -- | S, A | C |
| 16. | <i>Junonia atlites</i> (Linnaeus) | Grey Pansy | NE | -- | S, M, A, W | C |
| 17. | <i>Junonia hierta</i> (Fabricius) | Yellow Pansy | LC | -- | S, M, A, W | C |
| 18. | <i>Junonia lemonias</i> (Linnaeus) | Lemon Pansy | NE | -- | S, M, A, W | C |
| 19. | <i>Euthalia aconthea</i> (Cramer) | Common baron | NE | WPA-II | S, M, W | C |
| 20. | <i>Ypthima baldus</i> (Fabricius) | Common Five Ring | NE | -- | S, A | VC |
| 21. | <i>Vanessa cardui</i> (Linnaeus) | Painted Lady | LC | -- | S, A | C |
| 22. | <i>Hypolinas misippus</i> (Linnaeus) | Danaid Egg-fly | LC | WPA-I | M, W | O |
| 23. | <i>Hypolimnas bolina</i> (Linnaeus) | Great Egg-fly | NE | -- | M, W | O |

| | | | | | | |
|-----|---|-----------------------|----|--------|------------|----|
| 24. | <i>Mycalesis perseus</i> (Fabricius) | Common Bush Brown | NE | -- | S, A | O |
| 25. | <i>Ariadne merione</i> (Cramer) | Common Castor | NE | -- | S, M | O |
| 26. | <i>Tirumala limniace</i> (Cramer) | Blue Tiger | NE | -- | S, W | C |
| C. | Papilionidae | | | | | |
| 27. | <i>Papilio demoleus</i> (Linnaeus) | Lime butterfly | NE | -- | S, M, A | C |
| 28. | <i>Papilio polytes</i> (Linnaeus) | Common Mormon | NE | -- | S, M, A, W | VC |
| 29. | <i>Pachliopta aristolochiae</i> (Fabricius) | Common Rose | LC | -- | S, A | R |
| 30. | <i>Graphium doson</i> (C. & R. Felder) | Common Jay | NE | -- | S, M, A, W | C |
| 31. | <i>Graphium nomius</i> (Esper) | Spot Swordtail | NE | -- | S, W | R |
| D. | Pieridae | | | | | |
| 32. | <i>Eurema laeta</i> (Boisduval) | Spotless Grass Yellow | NE | -- | S, M, A, W | VC |
| 33. | <i>Eurema andersonii</i> (Moore) | One-spot Grass Yellow | LC | -- | M, W | VC |
| 34. | <i>Eurema hecabe</i> (Linnaeus) | Common Grass Yellow | LC | -- | S, M, A, W | VC |
| 35. | <i>Belenois aurota</i> (Fabricius) | Pioneer White | LC | -- | S, M, A | C |
| 36. | <i>Catopsilia pomona</i> (Fabricius) | Lemon Emigrant | NE | -- | S, M, A, W | VC |
| 37. | <i>Cepora nerissa</i> (Fabricius) | Common Gull | NE | WPA-II | A, W | O |
| 38. | <i>Ixias marianne</i> (Cramer) | White Orange-tip | NE | -- | S, M, W | O |
| 39. | <i>Pareronia hippia</i> (Fabricius) | Indian Wanderer | NE | -- | A, W | O |
| 40. | <i>Pieris canidia</i> (Linnaeus) | Indian Cabbage White | NE | -- | S, M, A | VC |
| 41. | <i>Pieris brassicae</i> (Linnaeus) | Large Cabbage White | NE | -- | S, M, A, W | VC |
| 42. | <i>Delias eucharis</i> (Drury) | Common Jezebel | NE | -- | S, A, W | C |
| 43. | <i>Leptosia nina</i> (Fabricius) | Psyche | NE | -- | S, M, W | C |
| E. | Hesperiidae | | | | | |
| 44. | <i>Pelopidas mathias</i> (Fabricius) | Small Branded Swift | NE | -- | S, M, W | O |
| 45. | <i>Borbo cinnara</i> (Wallace) | Rice Swift | NE | -- | S, M, A, W | VC |

Lemon Emigrant

Footnote= IUCN Status: LC= Least Concern; NE= Not Evaluated

Legal Status: WPA-I; WPA-II= legally protected species under the Indian Wildlife (Protection) Act,1972

Seasonal Status: S= Summer; M= Monsoon; W= Winter; A=Autumn

Local abundance status: VC-Very Common (> 100 sightings), C-Common (50-100 sightings), O-Occasional (15-50 sightings), and R-Rare (2-15 sightings)

Results

During the course of the study, 45 butterfly species of 33 genera belonging to five families were recorded in the Bakhira Sanctuary and its adjoining areas. Out of 45 species, 19 belong to Nymphalidae, 12 to Pieridae, seven to

Lycaenidae, five to Papilionidae, and two to Hesperidae. Butterfly species belonging to the family Nymphalidae were the most dominant (42.22%) (Fig.4) followed by Pieridae (26.66%), Lycaenidae (15.55%), Papilionidae (11.11%), and Hesperidae (04.44%). Among the 45 studied species, 6 (13.33%) were rare, 8 (17.77%) were occasional, 18 (40.00%) were common, and 13 (28.88%) were very commonly occurring (Fig.5). It was also observed that 12 species were present in all seasons. The highest number (39) of species was seen during summer (March to May). A total of 31 species were observed in winter (December to February). A total of 30 species were observed during autumn (September to November). The lowest number of species (27) was observed during the monsoon (June to August) season. Among these 45 recorded species, Common crow, plain tiger, and Indian cabbage white were found in high frequencies around the wetland area.

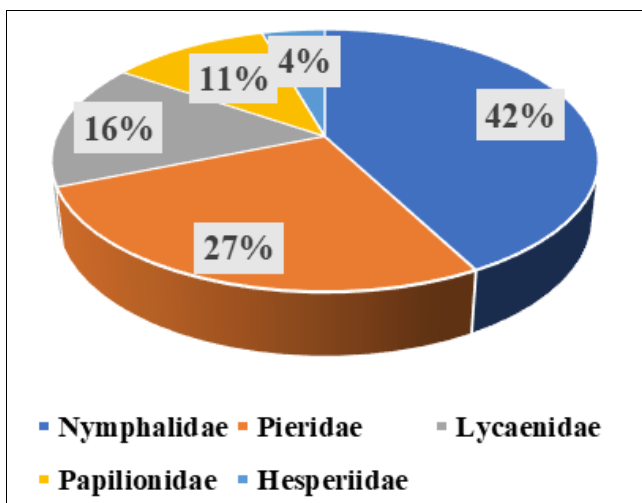


Fig 4: Family wise composition of species of butterfly at Bakhira Wetland

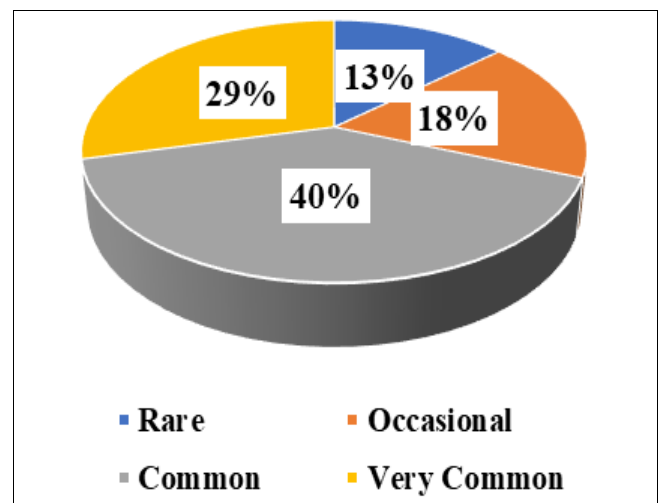


Fig 5: Local Abundance Status of butterfly species at Bakhira Wetland

Six of the study area's butterfly species have been classified as rare, indicating the need for Stringent conservation protocols. Two species, the Common pierrot, and Danaid egg-fly, belong to Schedule I, and Pea blue, Gram blue, Common gull, and Common baron belong to Schedule II of the Indian Wildlife (Protection) Act, 1972.

Discussion

There are around 1,504 species of butterflies on the Indian subcontinent, making up over 65% of all Indian wildlife (Tiple, 2011) [37]. Varied types of butterflies are supported by varied environments around our nation. There are 330 species in the Western Ghats alone, 48 of which are indigenous to the Nilgiri Biosphere Reserve. The state of Assam is home to around half of India's species of butterflies. In and around Jhansi, Kumar (2011 and 2012) [13, 14] documented 23 species from various locations. Uniyal and Bhargav (2007) [39] identified 24 species of butterflies from Bir Shikargarh Wildlife Sanctuary in Haryana, whereas Singh (2009) [1] found 147 species in the Kedarnath Musk Deer Reserve in the Garhwal Himalayas. Due to a lack of adequate research, the precise state of butterflies, especially in the northern and central regions of India, is still unclear (Kumar 2014) [12]. In comparison to studies on butterfly diversity around wetland ecosystems, Johny, S. (2023) [11] documented 69 butterfly species from a wetland and agrarian land that dominated the village of Ammadam in Kerala. Verma and Arya (2022) [42] reported 64 species from the Shyamlatil wetland of Uttarakhand. Subedi et al. (2020) identified 138 species of butterflies in Nepal's Central Himalayan Rupa Wetland. Sarath et al. (2017) [30] recorded 58 species from Kerala's Kole Wetlands, a Ramsar Site. Ansari et al. (2015) [1] recorded 53 species from the Surajpur, an urban wetland in the Gautam Budh Nagar District of Uttar Pradesh. Ramachandra et al. (2014) [27] recorded 115 butterfly species from Western Himalaya. Murugesan et al. (2013) [24] reported 63 species of butterflies in Puducherry's Oussudu Bird Sanctuary, an urban wetland. 28 species of butterflies were observed by Tewari and Rawat (2013) [35] from the Jhilmil Jheel Conservation Reserve, a marshy wetland in Uttarakhand's Gangetic plains of the Garhwal Himalayan Range. Chowdhury and Soren (2011) [7] reported 74 species from West Bengal's East Calcutta Wetlands, a Ramsar Site. Sharma and Joshi (2009) [31] documented 41 butterfly species from Punjab Shivalik. Thakur et al. 2006 [36] recorded 55 butterfly species from Sukhna Lake and catchment area of Chandigarh. Mehta et al. (2002) [18] documented 50 species from the Pong Dam Wetland of Himachal Pradesh, Western Himalaya. The current study is crucial for a better understanding of the health and integrity of the wetland ecosystem because there hasn't been any prior research on the diversity of butterflies in the Bakhira wetland area.

Even though conservation planners and managers have recently begun to pay attention to the Bakhira Wetland, our preliminary study highlights the significance of diverse ecological conditions and a mosaic of flora in maintaining a great diversity of butterfly fauna in the wetland environment. Six species of butterflies from the study area

are designated rare, and six different species are under Schedule I and II of the Indian Wildlife (Protection) Act, 1972, suggesting the need for strict conservation measures. In order to give Indian butterflies appropriate and adequate legal protection, an objective revision of the scheduled list is required. (Kunte, 2000) [16, 17].

The diversity and abundance of butterfly species are closely tied to the local microclimate and the presence of food plants in the environment (Kunte, 2000 [16, 17]; Ghosh and Mukherjee, 2018) [23]. The abundance of adult nectar plants and larval host plants is linked to the choice of butterflies for specific settings (Aiswarya et al., 2014). Wetlands surrounded by plantations offer butterflies more diverse ecological circumstances in the form of distinctive vegetation, basking spots with more sunlight, and grasslands with puddling spots at the lake's edge. In search of areas necessary for feeding, resting, mating, and reproducing, a number of free-ranging butterflies frequently visit the wetland (Verma and Arya 2022) [42]. The wetland possesses characteristic wetland vegetation: aquatic and marshy, dominated by Cyperaceae and Poaceae (Mishra and Narain, 2010) [22]. Some tree species are dispersed around the wetland, which is comparatively lesser in number. Major trees are such as Gular (*Ficus glomerata*), Sihor (*Strabulus asper*) *Dalbergia sissoo*, *Ficus sp.*, *Azadirachta indica*, *Mangifera indica*, *Acacia arabica* found far off from the Bakhira lake and aquatic plants such as Narkat (*Phragmites karkua*) (Johnson et al., 2021) [10] are host plants to several butterfly species. Aquatic plants such as *Hygrophila auriculata*, *Hygrophila costata*, and *Limnophila heterophylla* growing in the vicinity of water bodies and in wetland are found to be host plants for *Junonia atlites* and *Utricularia hispida* as larval hosts for several other butterflies (Baidya, 2021) [4].

Conclusion

In conclusion, a considerable number of butterfly species are found around Bakhira Wetland and the surrounding plantation area. The butterfly fauna of this region has never been described before. A sufficient summary of the conservation strategies for the study region must also be prepared, which requires further fieldwork and scientific studies on butterflies. Within the sanctuary, livestock grazing should be strictly prohibited. It is commendable to continuously monitor the butterfly fauna to assess the health of the wetland and to convince people that the environment should be improved sustainably. Proper management plans and techniques in the Bakhira Sanctuary can sustain a steady number of species and even increase the range of certain Terai species in the future on plantations of host trees and nectar trees in the region surrounding the wetland. As Bakhira Wetland has been recognized as a major wintering bird destination, this study highlights the location's significance for overall biodiversity. In addition, the research area promotes Bakhira Wetland as a favorable ecotourism destination for both residents and specialists from other regions.

Conflict of interest declaration

No conflicts of interest are declared by the author.

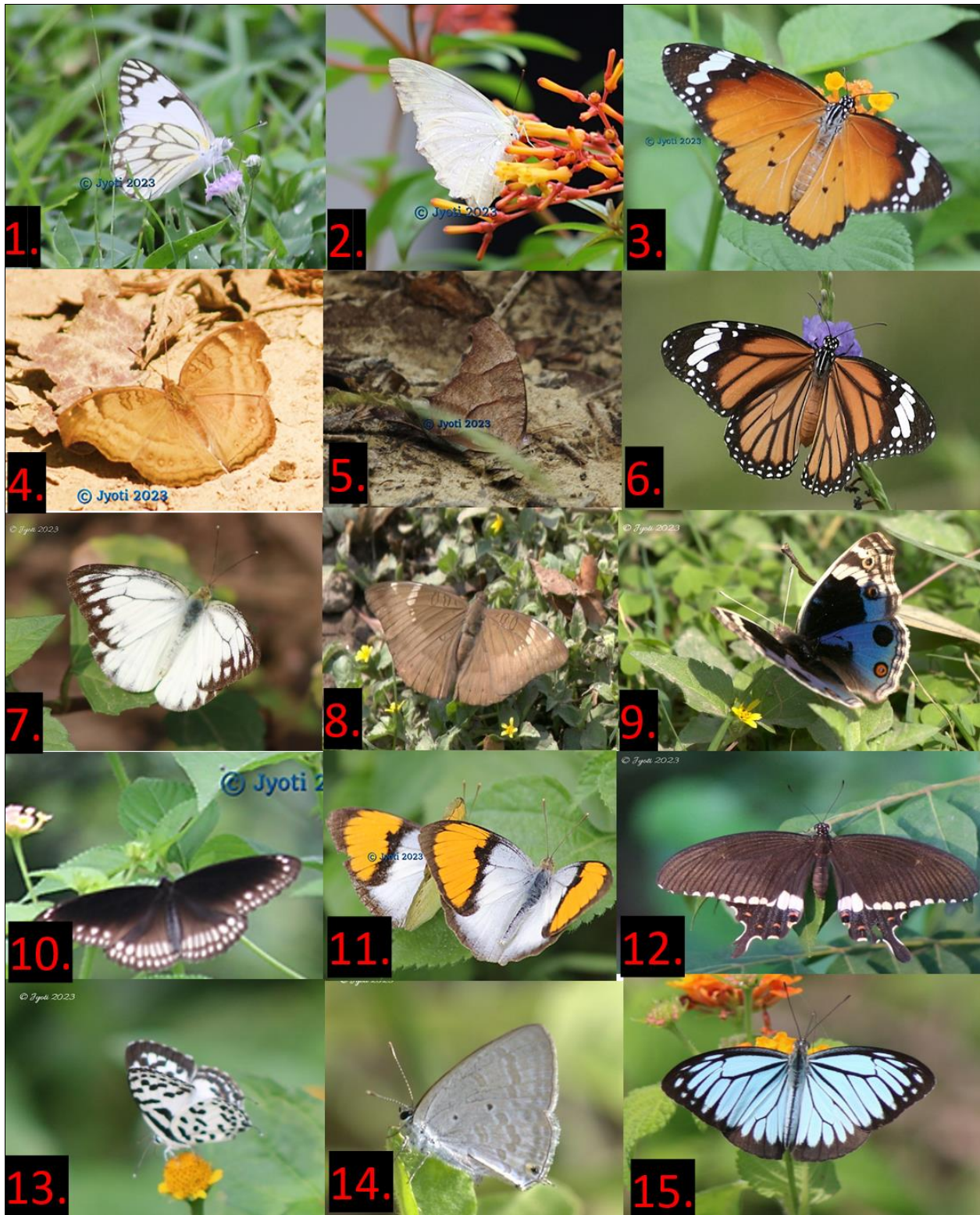


Fig 6: Pictures of different butterfly species reported in the study area 1) *Belenois aurota*, 2) *Catopsila pomona*, 3) *Danaus chrysippus* 4) *Junonia iphita* 5) *Melanitis leda* 6) *Danaus genutia* 7) *Cepora nerissa* 8) *Euthalia aconthea* 9) *Junonia orithya* 10) *Euploea core* 11) *Ixias marianne* 12) *Papilio polytes* 13) *Castalius rosimon* 14) *Catochrysops Strabo* 15) *Pareronia hippie*

References

1. Anon. Water Contents: Every Drop Counts,2011. Electronic database accessible at http://www.corbettfoundation.org/Water_contents.pdf (Accessed on 28 December 2011).
2. Ansari NA, Ram J, Nawab A. Structure and composition of Butterfly (Lepidoptera: Rhopalocera) fauna in Surajpur wetland, National Capital Region, India. Asian Journal of Conservation Biology,2015;4(1):43-53.
3. Kumar A, Dwivedi AK. Ecological Investigation of Bakhira Bird Sanctuary, Sant Kabir Nagar, Uttar Pradesh. International Journal of Trend in Scientific Research and Development,2022;6(4):1077-86.
4. Baidya S, Roy S, Roy AB. Scientific Note: A new aquatic host plant of *Junonia atlites*

- atlites* (Lepidoptera: Nymphalidae) from India. Tropical Lepidoptera Research,2021:124-26.
5. Barbier EB. Valuing ecosystem services as productive inputs. Economic Policy,2007:22(49):178-229. <https://doi.org/10.1111/j.1468-0327.2007.00174.x>
 6. Bonebrake TC, Ponisio LC, Boggs CL, et al. More than just indicators: a review of tropical butterfly ecology and conservation. Biological Conservation,2010:143(8):1831-41. <https://doi.org/10.1016/j.biocon.2010.04.044>
 7. Chowdhury S, Soren R. Butterfly (Lepidoptera: Rhopalocera) Fauna of East Calcutta Wetlands, West Bengal, India. Check List,2011:7(6):700-03.
 8. Evans WH. The Identification of Indian Butterflies. Bombay Natural History Society, 1932.
 9. International Wildfowl Research Bureau. Final Act of the International Conference on the Conservation of Wetlands and Waterfowl. Proceedings of International Conference on Conservation of Wetlands and Waterfalls, Ramsar, 1971, 1-17.
 10. Johnson JA, Sivakumar K, Vijaykumar C, et al. Detailed Project Report of Bakhira Bird Sanctuary, Uttar Pradesh, India. Wildlife Institute of India, Dehradun, 2021, 81.
 11. Johny S. Evaluation of Butterfly fauna of Ammadam, Thrissur, Kerala. International Journal of Ecology and Environmental Sciences,2023:49(4):443-6.
 12. Kehimkar I. The Book of Indian Butterflies. Bombay Natural History Society, Oxford University Press, Mumbai, 2016.
 13. Kumar A. A study of butterfly abundance and diversity in Jhansi, Uttar Pradesh, India. The Biosphere,2011:3(1):45-48.
 14. Kumar A. A report on the butterflies in Jhansi (U.P.) India. Journal of Applied and Natural Science,2012:4(1):51-55.
 15. Kumar A. Butterfly Abundance and Species Diversity in some Urban Habitats. International Journal of Advanced Research,2014:2(6):367-374.
 16. Kunte K. Butterflies of Peninsular India. Universities Press, Hyderabad, India, 2000.
 17. Kunte K. Butterflies of Peninsular India. Indian Academy of Sciences, Universities Press (India) Limited, 2000:254.
 18. Mehta HS, Thakur MS, Sharma RM, et al. Butterflies of Pong Dam Wetland, Himachal Pradesh. Bionotes,2002:4(2):37-38.
 19. Mensah BA, Kyerematen R, Annang T, et al. Influence of human activity on diversity and abundance of insects in three wetland environments in Ghana. Bonorowo Wetlands,2018:8(1):33-41. <https://doi.org/10.13057/bonorowo/w080104>
 20. Mishra H, Kumar V, Kumar A. Diversity and population status of waders (Aves) of Bakhira Tal, a natural wetland in District Sant Kabir Nagar, Uttar Pradesh, India. Biodiversity Journal,2016:7:331-336.
 21. Mishra H, Kumar V, Kumar A. Population structure and habitat utilization of migratory birds at Bakhira Bird Sanctuary, Uttar Pradesh, India. Pakistan Journal of Zoology,2020:52(1):247.
 22. Mishra S, Narain S. Floristic and ecological studies of Bakhira wetland, Uttar Pradesh, India. Indian Forester,2010:136:375-381.
 23. Mukherjee K, Ghosh D. Common banded peacock: record of new larval host plant of *Papilio crino* from Bankura, West Bengal,2018:33(12):11-14.
 24. Murugesan M, Arun PR, Prusty BAK. The butterfly community of an urban wetland system - a case study of Oussudu Bird Sanctuary, Puducherry, India. Journal of Threatened Taxa,2013:5(12):4672-4678. <http://dx.doi.org/10.11609/JoTT.o3056.4672-8>
 25. Nair AV, Mitra P, Bandyopadhyay SA. Studies on the diversity and abundance of butterfly (Lepidoptera: Rhopalocera) fauna in and around Sarojini Naidu college campus, Kolkata, West Bengal, India. Journal of Entomology and Zoology Studies,2014:2(4):129-134.
 26. Nimbalkar RK, Chandekar SK, Khunte SP. Butterfly diversity in relation to nectar food plants from Bhor Tahsil, Pune District, Maharashtra, India. Journal of Threatened Taxa,2011:3(3):1601-1609.
 27. Ramachandra TV, Joshi NV, Rao GR, et al. Ecological status of three micro watersheds in Western Himalaya,2014:331-347.
 28. Robbins RK, Opler PA. Butterfly diversity and a preliminary comparison with bird and mammal diversity. Biodiversity II: Understanding and Protecting Our Biological Resources,1997:69-82.
 29. RSAC (Remote Sensing Application Centre). Wetlands of Uttar Pradesh. RSAC Lucknow, Space Application Centre Ahmedabad India, 2009,108pp.
 30. Sarath S, Sreekumar ER, Nameer PO. Butterflies of the Kole Wetlands, a Ramsar Site in Kerala, India. Journal of Threatened Taxa,2017:9(5):10208-10215. <https://doi.org/10.11609/jott.3513.9.5.10208-10215>
 31. Sharma G, Joshi PC. Diversity of Butterflies (Lepidoptera: Insecta) from Dholbaha dam (Distt. Hoshiarpur) in Punjab Shivalik, India. Biological Forum - An International Journal,2009:1(2):11-14.
 32. Sharmila EJ, Thatheyus AJ, Susaritha S, et al. Seasonality of butterflies in Alagar Hills reserve forest, India. Entomon,2020:45(1):53-60. <https://doi.org/10.33307/entomon.v45i1.503>
 33. Singh AP. Butterflies of Kedarnath Musk deer Reserve, Garhwal Himalaya, India. Journal of Threatened Taxa,2009:1(1):37-48.
 34. Sondhi S, Kunte K. Butterflies of Uttarakhand - A Field Guide. Titli Trust, Dehradun. National Centre for Biological Sciences, Bengaluru, 2018.
 35. Tewari R, Rawat GS. Butterfly fauna of Jhilmil Jheel Conservation Reserve, Haridwar, Uttarakhand, India. Biological Forum - An International Journal,2013:5(2):22-26.
 36. Thakur MS, Mattu VK, Mehta HS. Studies on the butterflies of Sukhna and catchment area in Chandigarh, India. Journal of Entomological Research,2006:30(2):175.
 37. Tiple AD. Butterflies of Vidarbha region Maharashtra, India: a review with and implication for conservation. Journal of Threatened Taxa,2011:3(1):1469-1477.
 38. Tiple AD, Deshmukh VP, Dennis RLH. Factors influencing nectar plant resource visits by butterflies on a university campus: implications for conservation. Nota Lepidopteralogica,2006:28:213-224.

39. Uniyal VP, Bhargav VK. Assessment of butterflies in Bir Shikargarh Wildlife Sanctuary, Haryana. Tiger Paper,2007:34(3):13-15.
40. Varshney RK. Index Rhopalocera Indica Part II. Common names of butterflies from India and neighbouring countries. Records of Zoological Survey of India,1983:47:1-49.
41. Varshney RK, Smetacek PS, editors. A Synoptic Catalogue of the Butterflies of India. Indinov Publishing, New Delhi, 2015,261.
42. Verma A, Arya MK. Butterfly diversity and abundance in a sub-tropical wetland environment of Shyاملatal, Western Himalaya. Asian Journal of Conservation Biology,2022:11(1).
43. Wynter-Blyth MA. Butterflies of the Indian Region. Bombay Natural History Society, Mumbai, 1957, 523.
44. Xu T, Weng B, Yan D, et al. Wetlands of international importance: status, threats, and future protection. International Journal of Environmental Research and Public Health,2019:16(10):1818. <https://dx.doi.org/10.3390%2Fijerph16101818>