Journal of Threatened Taxa

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ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

SHORT COMMUNICATION

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26 December 2020 | Vol. 12 | No. 17 | Pages: 17347–17360
DOI: 10.11609/jott.5142.12.17.17347-17360

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 December 2020 | 12(17): 17347–17360
ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)
DOI: https://doi.org/10.11609/jott.5142.12.17.17347-17360
#5142 | Received 02 June 2019 | Final received 25 September 2020 | Finally accepted 20 November 2020
PLATINUM OPEN ACCESS

SHORT COMMUNICATION

Butterflies (Lepidoptera: Rhopalocera) of the undivided Midnapore District, West Bengal, India: a preliminary report

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Abstract: A butterfly study in the biodiversity rich biogeography transition zone of the undivided Midnapore District of West Bengal was carried out from March 2014 to March 2017. A total of 98 species of butterflies under five families, 19 subfamilies, and 70 genera were documented by the study. Maximum species diversity was found in Nymphalidae family with 31 species (31.63%), followed by Lycaenidae 24 species (24.48%), Hesperiidae-17 (17.34%), Pieridae 16 (16.32%), and the least by Papilionidae 10 (10.28%). Among the families, the highest common species (n=10) was recorded under the family Nymphalidae and maximum rare species (n=4) under the family Lycaenidae. Highest species richness has been recorded in post-monsoon season (97 species) followed by monsoon (78 species), winter (66 species), and pre-monsoon (47 species). During the study, five species of butterflies (*Castalius rosimon*, *Neptis jumbah*, *Discophora sondaica*, *Lethe europa*, and *Papilio clytia*) under Schedule-I, three species (*Euchrysops cnejus*, *Mahathala ameria*, and *Cepora nerissa*) under Schedule-II and three species (*Baoris farri*, *Hyarotis adrastus*, and *Euploea core*) under Schedule-IV were legally protected under the Indian Wildlife (Protection) Act, 1972. A good species to genera ratio (1.4: 1) along with 10 newly recorded species and their range extension provide information for better understanding of the ecology and distribution pattern of the butterfly fauna. The information of the study will thus help to develop conservation strategies for management of the unique bio-geographical transitional zone.

Keywords: Checklist, new records, species diversity, seasonality, biogeography transition zone.

Butterflies are highly sensitive to changes in the environment (Landres et al. 1988; Simberloff 1988), act as ecological indicators (New 1991; Pollard & Yates 1993; Thomas 2005; Bonebrake et al. 2010), and serve as surrogate species for floral and faunal diversity (Ehrlich & Raven 1964) by improving community structure. Further, they are primary consumers in forest ecosystems (Rosenberg et al. 1986) and their diversity increases with an increase in habitat scale and vegetation structure complex (Price 1975). Therefore, the conservation of butterflies is necessary to understand their natural history and ecology for the maintenance of ecosystem health.

Transition zones are defined as the boundaries between biogeographical regions, which represent areas of biotic overlap, and being favoured by ecological and historical changes allow a combination of taxa belonging to various biotic components (Morrone 2004). As the boundaries between these regions are areas of high biotic interaction (Ruggiero & Ezcurra 2003), with increased richness and abundance as well as unique ecotonal species (Odum 1953), they deserve special attention. The undivided Midnapore District of West Bengal which lies in the transition zone of three distinct biogeographic regions of India (Deccan Peninsula: Chotta-Nagpur biotic province, Gangetic Plains: Lower Gangetic Plain biotic province, and Coast: Eastern Coastal biotic province) makes it a perfect habitat for species diversity (Payra et

Editor: Jatishwor Singh Irungbam, Biology Centre CAS, Branišovská, Czech Republic. **Date of publication:** 26 December 2020 (online & print)

Citation: Mahata, A., N.P. Mishra & S.K. Palita (2020). Butterflies (Lepidoptera: Rhopalocera) of the undivided Midnapore District, West Bengal, India: a preliminary report. *Journal of Threatened Taxa* 12(17): 17347–17360. https://doi.org/10.11609/jott.5142.12.17.17347-17360

Funding: None.

Competing interests: The authors declare no competing interests.

Acknowledgements: The authors are thankful to the Head, Department of Biodiversity and Conservation of Natural Resources, Central University of Odisha, Koraput, Odisha for support and encouragement.

al. 2017; Samanta et al. 2017; Paria et al. 2018; Biswas et al. 2019) and acts as a connecting path of species distribution and migration from Western Ghats zone to northeastern zone (Abdulali 1949; Ali 1949; Hora 1949). Dry peninsular Sal forest and dry deciduous scrub vegetation along with different orchard plantation and agriculture practices in this region act as refuges for butterflies (Mahata et al. 2019).

Limited studies have been carried out on butterfly fauna in the undivided Midnapore District, and previous records from the region include the report of 112 species from the coastal area of Purba Medinipur (Payra et al. 2017) and 82 species from Midnapore Municipality area of West Midnapore District (Biswas et al. 2019) and remaining part was untouched. The present study aims to document butterflies in the undivided Midnapore district and prepare a checklist along with habitat ecology and management status for undertaking proper conservation action in near future.

Materials and Methods

Study sites

The study was conducted at undivided Midnapore district (22.953°–21.610° N & 88.211°–86.564° E) of West Bengal, India. The undivided Midnapore district is now divided into three districts (Purba Medinipur, Paschim Medinipur, and Jhargram) and covers an area of 14,081km^2. Of which 2,971km^2 is under forest cover contributing 3.35% of the total geographical area of the state (FSI 2017). This region covers northern dry mixed deciduous forest of Chotta-Nagpur Plateau ecozone, Eastern Highlands moist deciduous forests of the eastern part of Eastern Ghats along with dry peninsular Sal Forest, and deciduous scrub forest of Lower Gangetic Plain and saltwater mixed forest (Champion & Seth 1968; Figure 1). The topography of this region is highly variable from undulating southwestern region to Gangetic Plains and wetlands towards the eastern side. This undivided Midnapore District is characterized by

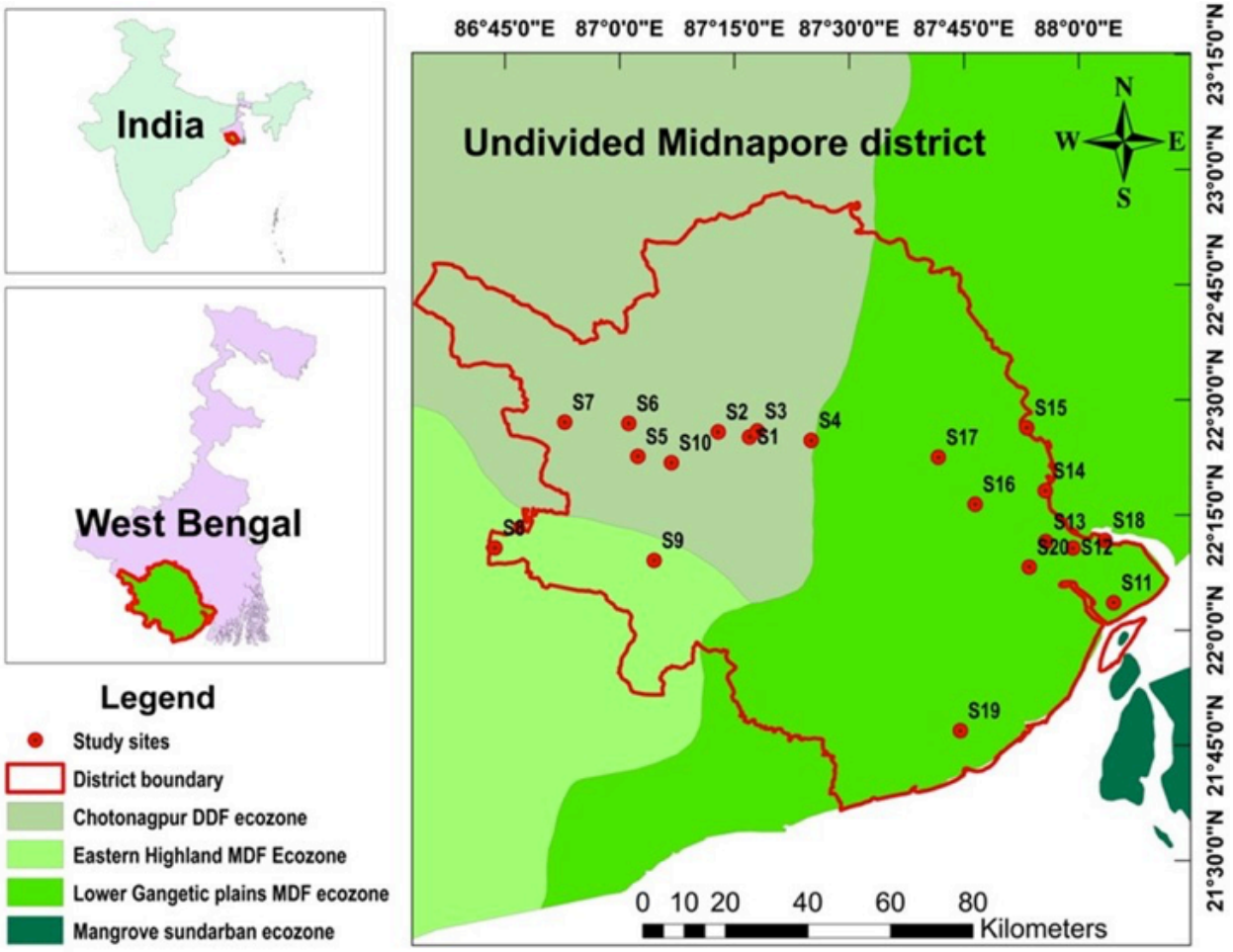

Figure 1. The map of study sites in undivided Midnapore District, West Bengal, India (DDF- Dry Deciduous Forest, MDF- Moist Deciduous Forest)

a variety of soil ranging from lateritic red soil towards the western region, alluvial along the rivers and sandy saline soil in the coastal belt. The average temperature in this region lies in between 10°C and 39°C with average annual precipitation of 1,752mm (Anonymous 2011a, b). The climate is characterized by tropical hot summer, cold winter, abundant rainfall and humidity in monsoon. Floods are quite regular in monsoon (Anonymous 2011a,b). A total of 20 different sites have been surveyed on the basis of different vegetation patterns to document the butterfly fauna. Elevations of these sites vary between 2–90 m (Table 1).

Data collection

The study was carried out over a period of three years during March 2014 to March 2017 in four distinct seasons: pre-monsoon (March to May), monsoon (June to August), post-monsoon (September to November), and winter (December to February). We adopted opportunistic sampling methods by walking through trails and recorded the species visually by using close focusing binocular (Olympus WP II, Olympus Corporation, Japan). Butterfly sampling was carried out only in good weather conditions (>10°C, <18 miles/hour wind speed and no rain) from 09.00 to 13.00 h. Butterflies were identified in the field with the help of field guides (Wynter-Blyth 1957; Kunte 2000; Kehimkar 2008). Butterflies which could not be identified in flight, were caught with butterfly-net, identified and then released safely. Photograph of the documented species was taken during the survey with the help of a DSLR camera (Nikon D5300 with Nikon 70–300 mm lens, Nikon Corporation, Japan) for further confirmations. Taxonomy and species names of butterflies were followed after Varshney & Smetacek (2015). A checklist of butterfly fauna was prepared along with their legal protection status. The status of a butterfly was decided based on the frequency of sighting of the butterfly during the total study period. Status of the butterfly was categorized under five categories: rare (R), not rare (NR), not common (NC), common (C), and very common (C). Butterflies having <20 % sightings were marked as rare butterflies, 20–40 % not rare, 40–60 % not common, 60–80 % common, and >80% very common (Payra et al. 2017; Samanta et al. 2017).

Results and Discussion

A total of 98 species of butterflies under five families, 19 subfamilies and 70 genera were documented from the study area (Table 2, Image 1, 2, 3, 4 & 5). Maximum species richness was observed in the family Nymphalidae with 31 species (31.63%), followed by Lycaenidae 24 species (24.48%), Hesperiidae 17 species (17.34%), Pieridae 16 species (16.32%), and least by Papilionidae 10 species (10.20%) (Table 2). The Nymphalidae family was very common in occurrence (10 species) whereas the maximum number of rare species were found in the Lycaenidae family (four species) (Table 2, Figure 3). Highest species richness was recorded in post-monsoon season (97 species), followed by monsoon (78 species), winter (66 species) and pre-monsoon (47 species) (Figure 4). Among the species recorded, 11 species are under schedule category of Indian Wildlife (Protection) Act 1972. Under Schedule-I, there are five species (*Castalius rosimon*, *Neptis jumbah*, *Discophora sondaica*, *Lethe europa*, and *Papilio clytia*), under Schedule-II, three species (*Euchrysops cnejus*, *Mahathala ameria*, and *Cepora nerissa*) and under Schedule-IV three species (*Baoris farri*, *Hyarotis adrastus*, and *Euploea core*) (Table 2). Five species are placed under Least Concern (LC) category and the rest 93 species are not assessed (IUCN 2020) (Table 2, Image 1, 2, 3, 4 & 5).

Among the recorded 17 species of Hesperiidae (Image 1), *Ampittia dioscorides* was very common, whereas *Badamia exclamationis* and *Matapa aria* were rare. *Baoris farri* and *Pelopidas subochracea* were recorded for the first time from the region. Among 24 species of Lycaenidae family (Image 2), *Arhopala atrax*, *Iraota timoleon*, *Mahathala ameria*, *Rathinda amor*, and *Virachola isocrates* were found to be rare. *Zizina otis* and *Arhopala atrax* were recorded for the first time from this region. *Iraota timoleon* and *Rathinda amor* were recorded only during post monsoon period. Out of 31 species recoded under Nymphalidae (Image 3), *Ariadne ariadne*, *A. merione*, *Danaus chrysippus*, *Danaus genutia*, *Euploea core*, *Acraea violae*, *Phalanta phalantha*, *Junonia almana*, *J. iphita*, and *J. lemonias* were very common whereas *Tirumala septentrionis* and *Discophora sondaica* were rare and *T. septentrionis*, *Phaedyma columella*, and *Ypthima baldus* were recorded for the first time from this region. Among 10 species under Papilionidae family (Image 4), *Papilio demoleus* was very common, whereas *Papilio crino* was rare and *Graphium nomius* was newly recorded from this region. Out of 16 species under Pieridae family (Image 5), *Delias eucharis* was very common and two species (*Eurema laeta* and *E. sari*) were recorded for the first time from undivided Midnapore region (Table 2, 3).

In our study, the presence of *Symphaedra nais*, *Danaus melanippus indicusand* and *Ypthima baldus* showed the species range extension from central India towards eastern India. Our study also recorded several Eastern Ghats species such as *Pseudozizeeria maha*,

Table 1. Location and Habitat conditions of the study sites.

Site No.	Site name	GPS Location	Elevation (m)	Habitat type	Vegetation type (dominant)	Management status
1	Gopegarh Eco-park (S1)	22.419°N 87.283°E	52.43	Managed park surrounded by natural vegetation	Non-native flowering plants and *Anacardium occidentale*	Managed by park authority, no grazing
2	Gurguripal Eco-park (S2)	22.430°N 87.215°E	48.77	Degraded park with natural vegetation	*Shorea robusta* and *Eucalyptus tereticornis*	Moderately anthropogenic activity, no grazing
3	VU Campus, Midnapore (S3)	22.432°N 87.299°E	58.22	Natural vegetation surrounded by Non-native flowering plants	*Anacardium occidentale* and *Eucalyptus tereticornis*	Least management, no grazing
4	Pathra (S4)	22.412°N 87.418°E	33.18	Natural rural vegetation with agriculture field	*Eucalyptus tereticornis, Bambusa* spp.	Grazing along with high human interference
5	Amlachati Vesaj Udyan (S5)	22.377°N 87.039°E	89	Managed herbal garden surrounded by sal forest.	Medicinal plants and *Shorea robusta*	Highly managed, no grazing
6	Jhargram Mini Zoo (S6)	22.449°N 87.020°E	81.38	Managed mini zoo in sal forest	*Shorea robusta*	Managed, no grazing
7	Chilkigarh (S7)	22.451°N 86.881°E	73.85	Rural area	*Shorea robusta*	Moderate grazing with anthropogenic activity
8	Jhilli Pakhiralaya (S8)	22.179°N 86.729°E	66.45	Forest area along marshy water body	*Shorea robusta*	No management, moderate grazing with anthropogenic activity
9	Kodopal fruit garden (S9)	22.151°N 87.075°E	35.66	Fruit orchards along with ornamental flowering plant	*Mangifera indica*, *Psidium guajava*, *Citrus* spp., *Zizyphus vulgaris*	Managed. No grazing and anthropogenic activity
10	Banantika (S10)	22.363°N 87.113°E	79.55	Fruit orchards	*Mangifera indica*, *Psidium guajava*, *Phyllanthus emblica*	Poorly managed. grazing and anthropogenic activities limited
11	Haldia (S11)	22.059°N 88.077°E	07.32	Park Garden	Ornamental flowering plants	Managed park
12	Mahishadal (S12)	22.178°N 87.988°E	06.10	Shrub land with natural fruit orchards	*Mangifera indica*	Rural area, No management
13	Nandakumar (S13)	22.192°N 87.928°E	04.87	Shrub land beside rail tracks	*Lantana camara*	No management
14	Tamluk (S14)	22.302°N 87.927°E	06.10	Natural Vegetation	Ornamental flowering plants	Urban area, no management
15	Kolaghat (S15)	22.439°N 87.887°E	09.45	Shrub land and agriculture land	*Hibiscus rosa-sinensis*, *Tabernaemontana divaricate*	Rural area, less grazing and anthropogenic activity
16	Moyna (S16)	22.273°N 87.775°E	04.57	Bogs and Marshy area	Grass and *Eucalyptus tereticornis*	Rural area, less grazing and anthropogenic activity
17	Khirai (S17)	22.375°N 87.694°E	06.10	Riverside agriculture land	*Oryza sativa, Tagetes* spp.	Rural area, less grazing and anthropogenic activity
18	Geonkhali (S18)	22.195°N 88.057°E	02.13	Riverside Park	Natural shrub and ornamental flower	Rural park, less management
19	Contai (S19)	21.782°N 87.742°E	07.32	Shrub land and agricultural fields	*Lantana Camara* and *Oryza sativa*	Rural area, less grazing and anthropogenic activity
20	Narghat (S20)	22.137°N 87.892°E	06.10	Riverside semi urban park	*Casuarina equisetifolia*	Semi urban area, less grazing and anthropogenic activity

Anthropogenic Activities (AA) are based upon number of human encounters and grazing seen during 30 minutes transect walk.
Least: 0–1 time, moderately AA: 3–4 times, highly AA: 8–10 times encounter

Junonia orithya, *Catopsilia pyranthe*, *Cepora nerissa*, *Spindasis vulcanus*, *Papilio demoleus*, *Arhopala atrax*, *Tarucus nara*, *Papilio hector*, and *Graphium nomius*. The study further revealed the presence of *Papilio crino* known from northeastern India as as well as species such as *Colotis amata*, *Catopsilia pomona*, *Catopsilia pyranthe*, *Cepora nerissa*, *Danaus chrysippus*, *Tirumala limniace*, *Zizeeria karsandra*, and *Catochrysops strabo* known from northwestern India (Kehimkar 2008). This species checklist represents the species distribution information for better understanding the butterfly fauna and making conservation strategies for similar biogeographical ecozones.

Conclusion

The present study provides a checklist of butterfly fauna in a biogeographically transitional region of undivided Midnapore District; the first attempt at a relatively larger scale documentation of butterflies of this region. A record of 98 species of butterfly along

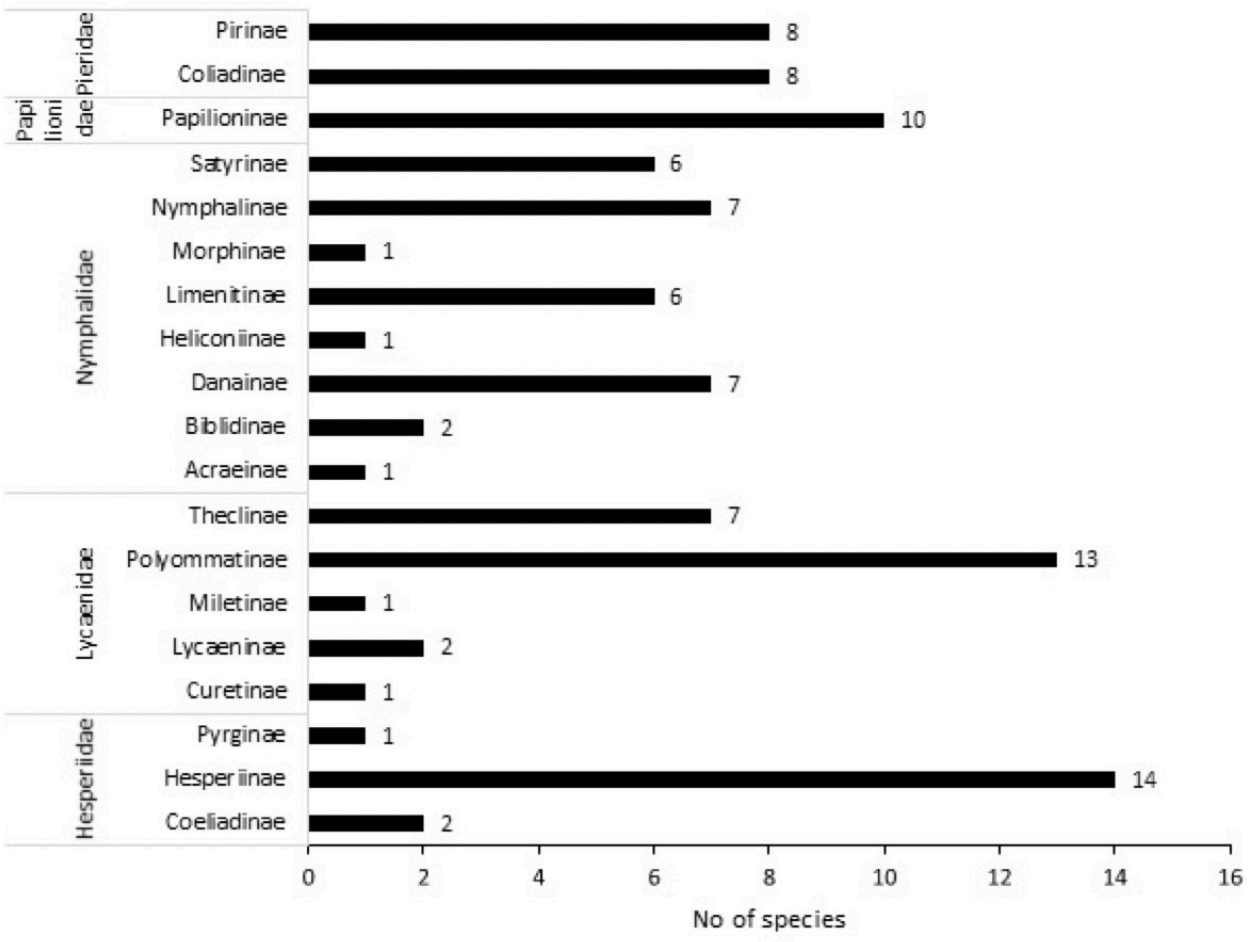

Figure 2. Subfamily wise recorded butterfly species in study sites.

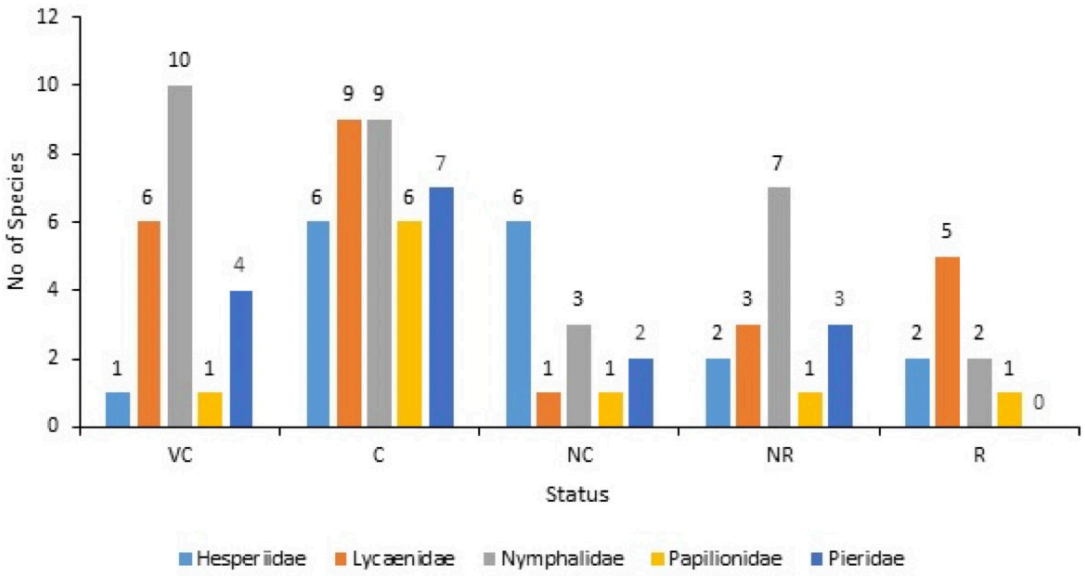

Figure 3. Status of butterfly in the study: VC—Very Common | C—Common | NC—Not common | NR—Not Rare | R—Rare.

Table 2. Checklist of butterfly fauna recorded in the study.

	Scientific name	Common name	Status	Flight period	IUCN/IW(P)A
Family Hesperiidae					
Subfamily Coeliadinae					
1	*Badamia exclamationis* (Fabricius, 1775)	Brown Awl	R	2, 3	NE
2	*Hasora chromus* (Cramer, [1780])	Common Banded Awl	NR	1, 2, 3,4	NE
Subfamily Hesperiinae					
3	*Suastus gremius* (Fabricius, 1798)	Indian Palm Bob	C	1,3	NE
4	*Ampittia dioscorides* (Fabricius, 1793)	Bush Hopper	VC	3,4	NE
5	*Baoris farri* (Moore, 1878)*	Paintbrush Swift	NC	2,3,4	NE/ Sch IV
6	*Borbo cinnara* (Wallace, 1866)	Rice Swift	NC	2,3,4	NE
7	*Erionota thrax* (Linnaeus, 1767)	Palm Redeye	NR	2,3	NE
8	*Hyarotis adrastus* (Stoll, [1780])	Tree Flitter	NC	1,3	NE/ Sch IV
9	*Iambrix salsala* (Moore, [1866])	Chestnut Bob	C	1, 2, 3, 4	NE
10	*Matapa aria* (Moore, [1866])	Common Redeye	R	1, 4	NE
11	*Parnara guttatus* (Bremer & Grey, [1852])	Straight Swift	NC	2,3,4	NE
12	*Pelopidas subochracea (Moore, 1878)**	Moore's Swift	C	1,2,3,4	NE
13	*Pelopidas thrax* (Huebner, [1821])	Small Branded Swift	C	2,3,4	NE
14	*Telicota colon* (Fabricius, 1775)	Common Palm Dart	NC	2,3,4	NE
15	*Telicota bambusae* (Moore, 1878)	Dark Palm Dart	C	3,4	NE
16	*Udaspes folus* (Cramer, [1775])	Grass Demon	NC	2,3,4	NE
Subfamily Pyrginae					
17	*Spialia galba* (Fabricius, 1793)	Indian Skipper	C	1,2,3,4	NE
Family Lycaenidae					
Subfamily Curetinae					
18	*Curetis thetis* (Drury,1773)	Indian Sunbeam	C	3,4	NE
Subfamily Lycaeninae					
19	*Pseudozizeeria maha* (Kollar, [1844])	Pale Grass Blue	VC	1,2,3,4	NE
20	*Zizina otis* (Fabricius, 1787)*	Lesser Grass Blue	VC	1,2,3,4	NE
Subfamily Miletinae					
21	*Spalgis epius* (Westwood, 1852)	Common Apefly	NR	2, 3	NE
	Subfamily Polyommatinae				NE
22	*Anthene emolus* (Godart, 1824)	Common Ciliate Blue	C	2,3,4	NE
23	*Castalius rosimon* (Fabricius, 1775)	Common Pierrot	VC	1, 2, 3	NE/ Sch I (Part IV)
24	*Catochrysops strabo* (Fabricius, 1793)	Forgetmenot	C	1,2,3,4	NE
25	*Chilades lajus* (Stoll, [1780])	Lime Blue	C	2,3,4	NE
26	*Euchrysops cnejus* (Fabricius,1798)	Gram Blue	NR	2,3,4	NE/ Sch II (Part II)
27	*Jamides bochus* (Stoll, [1782])	Dark Cerulean	C	1,2,3,4	NE
28	*Jamides celeno* (Cramer, [1775])	Common Cerulean	C	3,4	NE
29	*Luthrodes pandava* (Horsfield, [1829])	Plains Cupid	VC	1.2.3.4	NE
30	*Neopithecops zalmora* (Butler, 1870)	Quaker	VC	2,3,4	NE
31	*Prosotas dubiosa* (Semper, [1879])	Tailless Lineblue	C	1,2,3	NE
32	*Tarucus nara* (Kollar, 1848)	Striped/ Rounded Pierrot	C	2,3,4	NE

	Scientific name	Common name	Status	Flight period	IUCN/IW(P)A
33	*Zizeeria karsandra* (Moore, 1865)	Dark Grass Blue	C	1,2,3,4	NE
34	*Zizula hylax* (Fabricius, 1775)	Tiny Grass Blue	VC	1,2,3,4	NE
Subfamily Theclinae					
35	*Arhopala atrax* (Hewitson, 1862)*	Indian Oakblue	R	2,3	NE
36	*Iraota timoleon* (Stoll, [1790])	Silverstreak Blue	R	3	NE
37	*Mahathala ameria* (Hewitson, 1862)	Falcate Oakblue	R	3	NE/ Sch II (Part II)
38	*Rapala manea* (Hewitson, 1863)	Slate Flash	NR	2,3	NE
39	*Rathinda amor* (Fabricius, 1775)	Monkey Puzzle	R	3	NE
40	*Spindasis vulcanus* (Fabricius, 1775)	Common Silverline	NC	2, 3	NE
41	*Virachola isocrates* (Fabricius, 1793)	Common Guava Blue	R	1, 3, 4	NE
Family Nymphalidae					
Subfamily Biblidinae					
42	*Ariadne* (Linnaeus, 1763)	Angled Castor	VC	1, 2,3,4	NE
43	*Ariadne merione* (Cramer, [1777])	Common Castor	VC	1, 2,3, 4	NE
	Subfamily Danainae				NE
44	*Danaus chrysippus* (Linnaeus, 1758)	Plain Tiger	VC	1,2,3,4	NE
45	*Danaus genutia* (Cramer, [1779])	Common Tiger/ Striped Tiger	VC	1,2,3,4	NE
46	*Danaus melanippus indicus* (Fruhstorfer, 1899)	White Tiger	C	2,3,4	NE
47	*Euploea core* (Cramer, [1780])	Common Crow	VC	1, 2,3, 4	LC/Sch IV
48	*Euploea klugii* kollari (C. & R. Felder, 1865)	King Crow	C	3,4	NE
49	*Tirumala limniace* (Cramer, [1775])	Blue Tiger	NC	1, 2, 3	NE
50	*Tirumala septentrionis* (Butler, 1874)*	Dark Blue Tiger	R	2,3	NE
Subfamily Acraeinae					
51	*Acraea violae* (Fabricius, 1793)	Tawny Coster	VC	1, 2, 3,4	NE
Subfamily Heliconiinae					
52	*Phalanta phalantha* (Drury, [1773])	Common Leopard	VC	1, 2,3, 4	NE
Subfamily Limenitinae					
53	*Euthalia aconthea* (Cramer, [1777])	Common Baron	NR	2, 3	NE
54	*Moduza procris* (Cramer, [1777])	Commander	C	2, 3	NE
55	*Neptis hylas* (Linnaeus, 1758)	Common Sailer	C	2, 3, 4	NE
56	*Neptis jumbah* Moore, [1858]	Chestnut-streaked Sailer	NR	2, 3	NE/ Sch I (Part IV)
57	*Phaedyma columella* (Cramer, [1780])*	Short-banded Sailer	NC	2,3,4	NE
58	*Symphaedra nais* (Forster, 1771)	Baronet	C	1, 2, 3	NE
Subfamily Morphinae					
59	*Discophora sondaica* Boisduval, 1836	Common Duffer	R	3	NE/ Sch I (Part IV)
Subfamily Nymphalinae					
60	*Hypolimnas bolina* (Linnaeus, 1758)	Great Eggfly	c	1,2,3,4	NE
61	*Junonia almana* (Linnaeus, 1758)	Peacock Pansy	VC	2,3,4	LC
62	*Junonia atlites* (Linnaeus, 1763)	Grey Pansy	c	2,3,4	NE
63	*Junonia hierta* (Fabricius, 1798)	Yellow Pansy	NC	2,3	LC
64	*Junonia iphita* (Cramer, [1779])	Chocolate Pansy	VC	1, 2, 3, 4	NE
65	*Junonia lemonias* (Linnaeus, 1758)	Lemon Pansy	VC	1,2,3,4	NE
66	*Junonia orithya* (Linnaeus, 1758)	Blue Pansy	NR	2, 3	NE

	Scientific name	Common name	Status	Flight period	IUCN/IW(P)A
Subfamily Satyrinae					
67	*Elymnias hypermnestra* (Linnaeus, 1763)	Common Palmfly	NR	2, 3, 4	NE
68	*Lethe europa* (Fabricius, 1775)	Bamboo Treebrown	NR	3,4	NE/Sch I (Part IV)
69	*Melanitis leda* (Linnaeus, 1758)	Common Evening Brown	C	**1, 2, 3, 4**	NE
70	*Mycalesis perseus* (Fabricius, 1775)	Common Bush Brown	NR	2,3,4	NE
71	*Ypthima baldus* (Fabricius, 1775)*	Common Fivering	NR	2, 3, 4	NE
72	*Ypthima huebneri* Kirby, 1871	Common Fourring	C	1,2,3,4	NE
Family Papilionidae					
Subfamily Papilioninae					
73	*Graphium agamemnon* (Linnaeus, 1758)	Tailed Jay	C	1,2,3	NE
74	*Graphium doson* (C. & R. Felder, 1864)	Common Jay	C	1, 2, 3	NE
75	*Graphium nomius* (Esper, 1799)*	Spot Swordtail	C	1,2,3	NE
76	*Pachliopta aristolochiae* (Fabricius, 1775)	Common Rose	C	1, 2, 3, 4	NE
77	*Papilio clytia* Linnaeus, 1758	Common Mime	C	2, 3	NE/Sch I (Part IV)
78	*Papilio crino* Fabricius, 1793	Common Banded Peacock	R	3, 4	NE
79	*Papilio demoleus* Linnaeus, 1758	Lime Butterfly	VC	1,2,3,4	NE
80	*Papilio hector* (Linnaeus, 1758)	Crimson Rose	NR	1,2,3,4	NE
81	*Papilio polymnestor* Cramer, [1775]	Blue Mormon	NC	2,3,4	NE
82	*Papilio polytes* Linnaeus, 1758	Common Mormon	C	2, 3, 4	NE
Family Pieridae					
Subfamily Coliadinae					
83	*Catopsilia pomona* (Fabricius, 1775)	Common Emigrant	C	1, 2, 3, 4	NE
84	*Catopsilia pyranthe* (Linnaeus, 1758)	Mottled Emigrant	VC	1,2,3,4	NE
85	*Eurema andersoni* Moore, 1886	One-spot Grass Yellow	C	1,2,3,4	LC
86	*Eurema blanda* (Boisduval, 1836)	Three-spot Grass Yellow	VC	1,2,3,4	NE
87	*Eurema brigitta* (Stoll, [1780])	Small Grass Yellow	VC	1,2,3,4	LC
88	*Eurema hecabe* (Linnaeus, 1758)	Common Grass Yellow	C	2, 3, 4	NE
89	*Eurema laeta* (Boisduval, 1836)*	Spotless Grass Yellow	C	1,2,3,4	NE
90	*Eurema sari* (Horsfield)*	Chocolate Grass Yellow	C	2, 3, 4	NE
Subfamily Pirinae					
91	*Appias libythea olferna* (Swinhoe, 1890)	Striped Albatross	NR	2,3	NE
92	*Cepora nerissa* (Fabricius, 1775)	Common Gull	C	2, 3	NE/Sch II (Part II)
93	*Colotis amata* (Cramer, 1775)	Small Salmon Arab	NC	1,2,4	NE
94	*Delias eucharis* (Drury, 1773)	Common Jezabel	VC	1, 2, 3, 4	NE
95	*Ixias pyrene* (Linnaeus, 1764)	Yellow Orange Tip	NC	1,2,3	NE
96	*Leptosia nina* (Fabricius, 1793)	Psyche	C	1,2,4	NE
97	*Pareronia valeria* (Cramer, [1776])	Common Wanderer	NR	2,3	NE
98	*Pieris canidia* (Linnaeus, 1768)	Indian Cabbage White	NR	2,3	NE

VC—very common | C—common | NC—not common | NR—not rare | R—rare | 1—pre-monsoon | 2—monsoon | 3—post-monsoon | 4—winter | NE—not evaluated | LC—Least Concern | Sch—schdule.
* indicates newly recorded species from this region

Table 3. List of newly recoded species along with their distribution and legal protection status.

	New records	Distribution[a]	Legal protection[b]	Reference
Family Hesperiidae				
1	*Baoris farri*	West Bengal (Alipurduar, South 24 Parganas, Bankura, Purulia district), NEI, A & N Is., SI, CI	NE/ Sch IV	Saji & Manoj (2020)
2	*Pelopidas subochracea*	West Bengal (northern Bengal, southwestern Bengal), NEI, SI, CI	NE	Saji (2020)
Family Lycaenidae				
3	*Zizina otis*	India	NE	Saji & Mahajan (2020)
4	*Arhopala atrax*	West Bengal (Alipurduar, Bankura, Purulia district) NEI, CI, NI	NE	Anonymous (2020a)
Family Nymphalidae				
5	*Tirumala septentrionis*	NEI, NI, SI, CI	NE	Saji et al. (2020)
6	*Phaedyma columella*	West Bengal (Alipurduar, Bardhaman district), NEI, NI, SI, CI, A&N Is	NE	Churi & Bagli (2020)
7	*Ypthima baldus*	West Bengal (Northern Bengal to southern Bengal), NEI, NI, CI, SI	NE	Ogale & Saji (2020)
Family Papilionidae				
8	*Graphium nomius*	West Bengal (Bardhaman, Bankura, Purulia district), SI, CI, NEI	NE	Churi (2020)
Family Pieridae				
9	*Eurema laeta*	West Bengal (Bankura, Purulia district), SI, CI, NEI, NI	NE	Bhakare & Bhagwat (2020)
10	*Eurema sari*	NEI, SI	NE	Anonymous (2020b)

[a] Emphasis on regional distribution along with National level distribution (NEI: Northeastern India, NI: Northern India, SI: Southern India, CI: Central India, A&N Is: Andaman & Nicobar island of newly recoded species in this study.
[b] Legal protection of newly recorded butterfly species based on IUCN Red list (NE: Not Evaluated)/IW(P)A (Sch IV: Schedule IV).

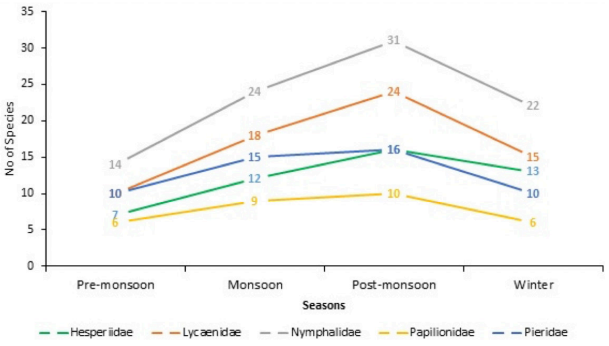

Figure 4. Flight period of butterfly fauna during entire study.

with good species to genera ratio (1.4: 1) indicates good butterfly diversity in the region. Presence of 11 legally protected species under the Indian Wildlife (Protection) Act, 1972 and 10 newly recorded species from this region draws attention towards the conservation priorities of this flagship species. The present comprehensive checklist of the butterfly fauna along with their habitat types and seasonality provide information for better understanding the ecology and distribution pattern of the butterfly fauna so that it can help to develop specific conservation measures for this unique biogeographical transitional zone.

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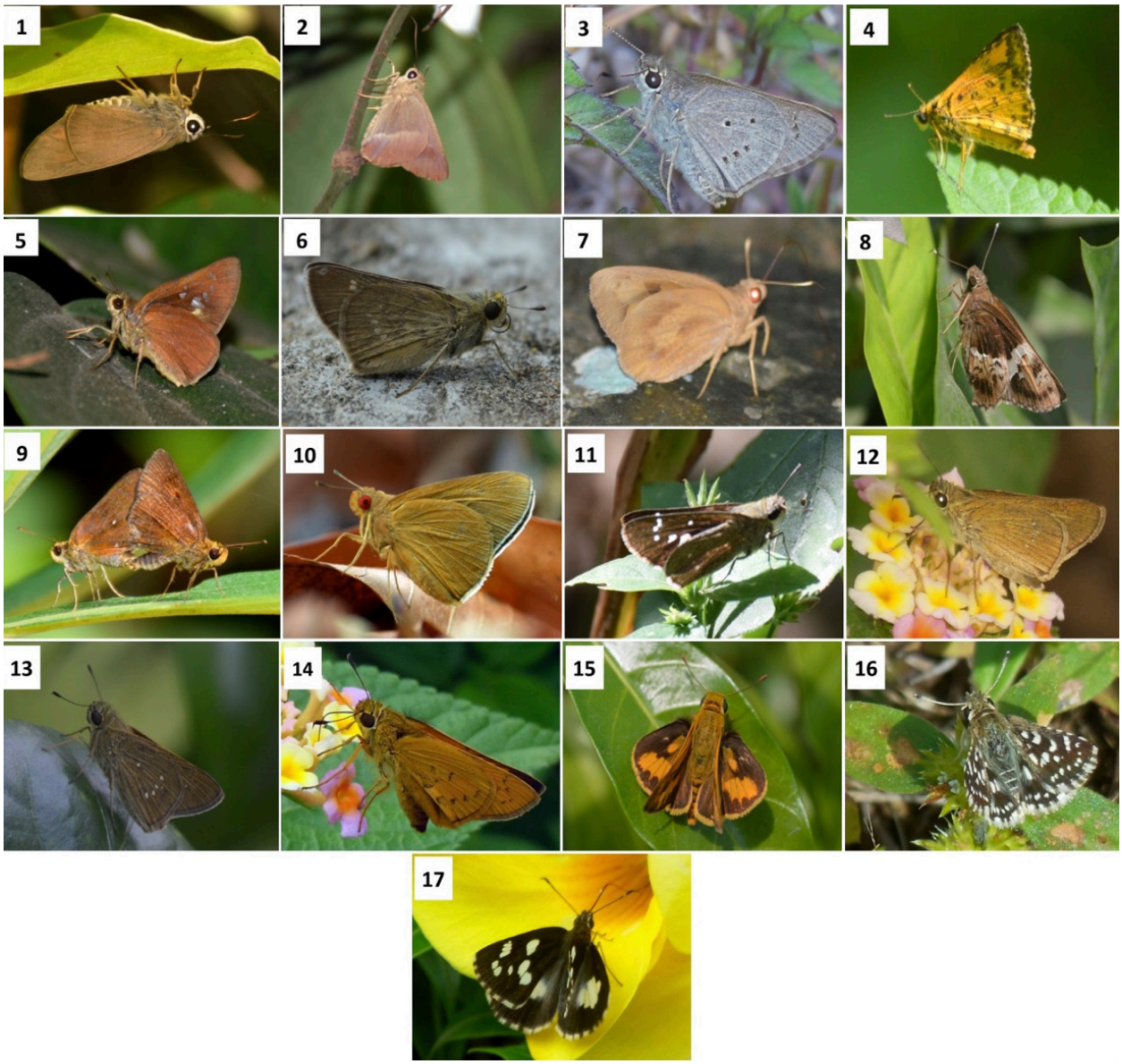

Image 1. Species of Hesperiidae family recorded in the present study: 1—*Badamia exclamationis* | 2—*Hasora chromus* | 3—*Suastus gremius* | 4—*Suastus gremius* | 5—*Baoris farri* * | 6—*Borbo cinnara* | 7—*Erionota thrax* | 8—*Hyarotis adrastus* | 9—*Iambrix salsala* | 10—*Matapa aria* | 11—*Parnara guttatus* | 12—*Pelopidas subochracea* * | 13—*Pelopidas thrax* | 14—*Telicota colon* | 15—*Telicota bambusae* | 16—*Udaspes folus* | 17—*Spialia galba.*

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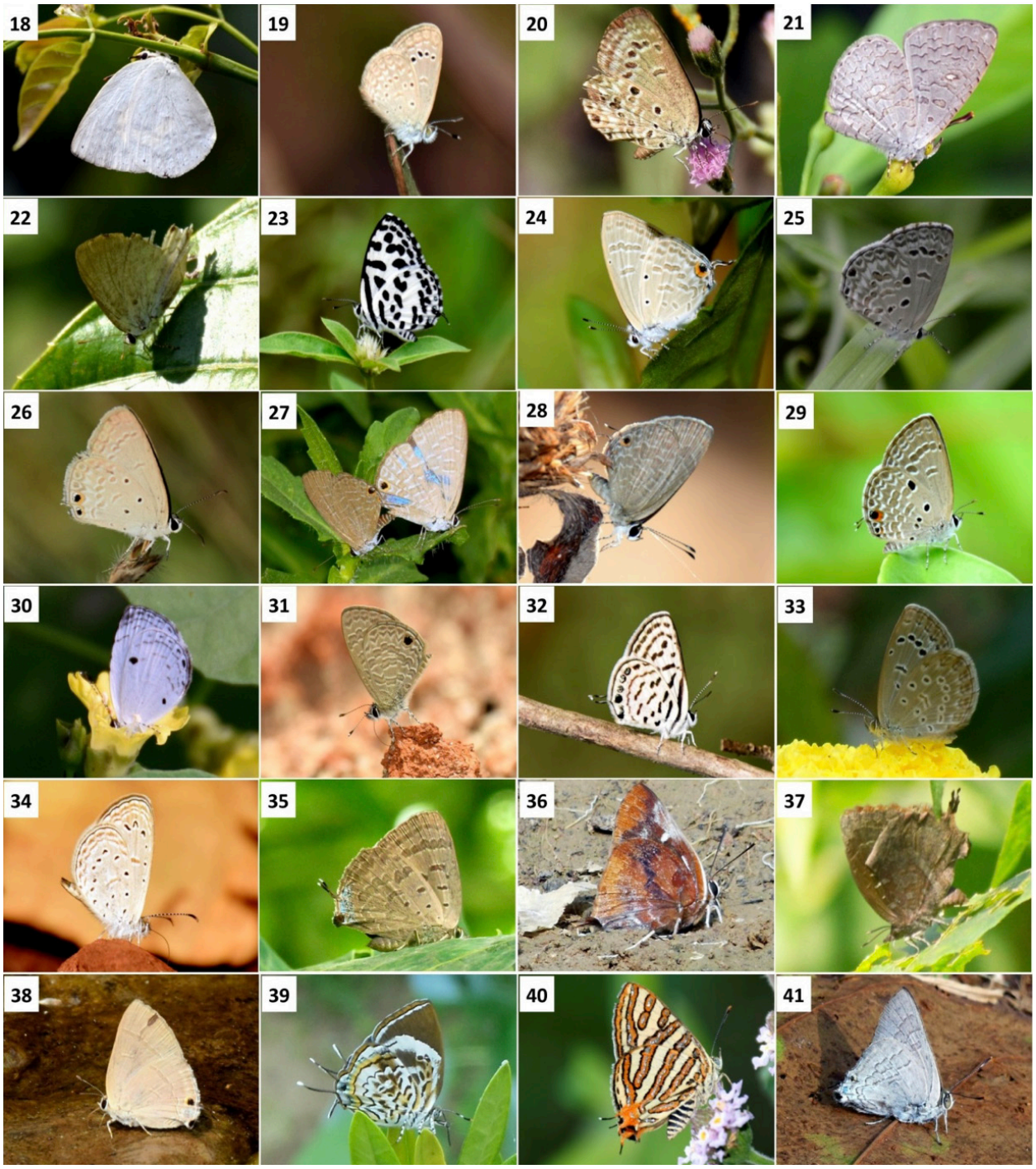

Image 2. Species of Lycaenidae family recorded in the present study: 18—*Curetis thetis* | 19—*Pseudozizeeria maha* | 20—*Zizina otis* *| 21—*Spalgis epius* | 22—*Anthene emolus* | 23—*Castalius rosimon* | 24—*Catochrysops strabo* | 25—*Chilades lajus* | 26—*Euchrysops cnejus* | 27—*Jamides bochus* | 28—*Jamides celeno* | 29—*Luthrodes pandava* | 30—*Neopithecops zalmora* | 31—*Prosotas dubiosa* | 32—*Tarucus nara* | 33—*Zizeeria karsandra* | 34—*Zizula hylax*| 35—*Arhopala atrax* * | 36—*Iraota timoleon* | 37—*Mahathala ameria* | 38—*Rapala manea* |39—*Rathinda amor* | 40—*Spindasis vulcanus* | 41—*Virachola Isocrates*.

Image 3. Species of Nymphalidae family recorded in the present study: 42—*Ariadne ariadne* | 43—Ariadne merione | 44—*Danaus chrysippus* | 45—*Danaus genutia* | 46—*Danaus melanippus indicus* | 47—*Euploea core* | 48—*Euploea klugii* kollari | 49—*Tirumala limniace* | 50—*Tirumala septentrionis* *| 51—*Acraea violae* | 52—*Phalanta phalantha* | 53—*Euthalia aconthea* | 54—*Moduza procris*| 55—*Neptis hylas*| 56—*Neptis jumbah* | 57—*Phaedyma columella* * | 58—*Symphaedra nais* | 59—*Discophora sondaica* | 60—*Hypolimnas bolina* | 61—*Junonia almanac* | 62—*Junonia atlites* | 63—*Junonia hierta* | 64—*Junonia iphita* | 65—*Junonia lemonias* | 66—*Junonia orithya* | 67—*Elymnias hypermnestra* | 68—*Lethe europa* | 69—*Melanitis leda* | 70—*Mycalesis perseus* | 71—*Ypthima baldus* * | 72—*Ypthima huebneri*.

Image 4. Species of Papilionidae family recorded in the present study: 73—*Graphium Agamemnon* | 74—*Graphium doson* | 75—*Graphium nomius** | 76—*Pachliopta aristolochiae* | 77—*Papilio clytia* | 78–*Papilio crino* | 79—*Papilio demoleus* | 80—*Papilio hector* | 81—*Papilio polymnestor* | 82—*Papilio polytes*.

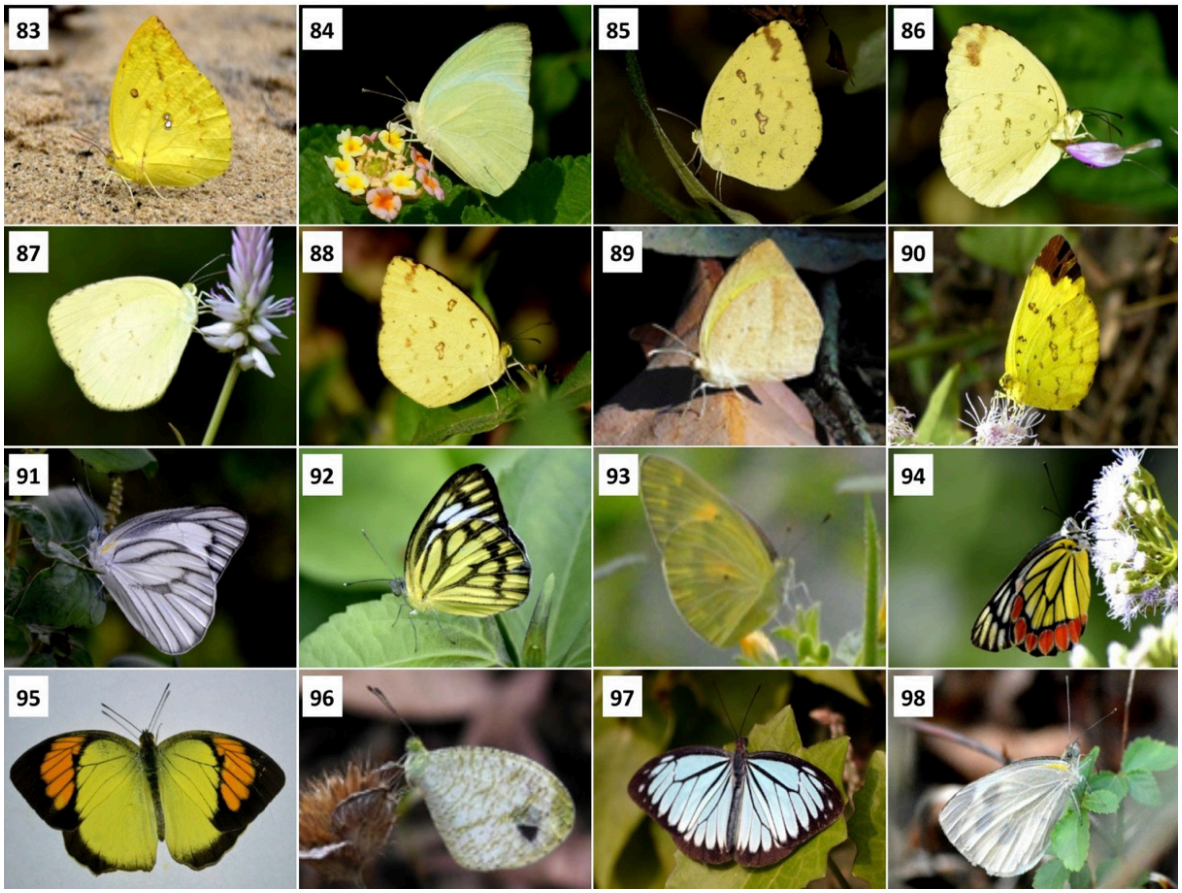

Image 5. Species of Pieridae family recorded in the present study: 83—*Catopsilia Pomona* | 84—*Catopsilia pyranthe* | 85—*Eurema andersoni* | 86—*Eurema blanda* | 87—*Eurema brigitta* | 88—*Eurema hecabe* | 89—*Eurema laeta* * | 90—*Eurema sari* * | 91—*Appias libythea olferna* | 92—*Cepora nerissa* | 93–*Colotis amata* | 94—*Delias eucharis* | 95—*Ixias pyrene* | 96—*Leptosia nina* | 97—*Pareronia valeria* | 98—*Pieris canidia*.

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Journal of Threatened Taxa

www.threatenedtaxa.org

PLATINUM OPEN ACCESS

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

December 2020 | Vol. 12 | No. 17 | Pages: 17263–17386
Date of Publication: 26 December 2020 (Online & Print)
DOI: 10.11609/jott.2020.12.17.17263-17386

Publisher & Host

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