

Diversity of butterflies (Lepidoptera: Rhopalocera) in Bhubaneswar, Odisha, India

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Abstract

The loss and fragmentation of habitat caused by rapid urbanization can have devastating effects, both at regional and global level. In this study, butterfly species diversity has been assessed in Bhubaneswar, India, as a model geographical region for understanding the biology of the local population and its dynamics. In total 107 butterfly species have been documented, with the highest number of species being recorded from the family Nymphalidae (31.77%), followed by Lycaenidae (25.23%), Hesperiidae (23.36%), Pieridae (11.21%) and Papilionidae (8.41%). Out of these, 17 species are new reports for the city and nine species are legally protected in India under the Wildlife (Protection) Act, 1972. Sørensen's diversity index and one-way ANOVA have been used to establish the relation between species diversity and habitat. The present investigation provides baseline data for future research and conservation of species in places like the model city, which face rapid urbanization.

Keywords: Bhubaneswar; butterfly diversity; conservation; Lepidoptera; new reports; scheduled species

Introduction

Order Lepidoptera comprises butterflies and moths which belong to the class Insecta (Kunte, 2000; Kawahara and Breinholt, 2014). Butterflies occupy a vital position in the ecosystem, acting as pollinators, pollution indicators, good source of food, and have aesthetic importance (Klein *et al.*, 2007; Syaripuddin *et al.*, 2015). Their studies have made significant contributions towards the understanding of biogeography, behaviour, coevolution, conservation, development, ecological genetics, global warming, mimicry, population ecology, sexual selection, speciation, symbiotic associations, and systematics (Aduse-Poku *et al.*, 2015; Kozak *et al.*, 2015; Kronforst and Papa, 2015; Manesi *et al.*, 2015; Wang Wei *et al.*, 2016; van Bergen *et al.*, 2017). Mature and immature individuals that have narrow niches often show specificity towards their host plants (Tiple *et al.*, 2011; Salz and Fartmann, 2017; Nallu *et al.*, 2018; Verspagen *et al.*, 2020).

Therefore, butterflies are regarded as good indicators of the quality of microhabitat and the extent of associated anthropogenic disturbances (Ruszczyk and Silva, 1997; Kehimkar, 2016). Approximately, 18,768 species of butterflies have been recorded worldwide (Van Nieukerken *et al.*, 2011) and recent findings suggest that India hosts 1318 species in its subcontinent, out of which 89 species belong to Papilionidae, 277 species belong to Hesperiidae, 92 species belong to Pieridae, 19 species belong to Riodinidae, 380 species belong to Lycaenidae, and 461 species belong to Nymphalidae (Cotton *et al.*, 2015; Kehimkar, 2016). Butterfly works in

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Indian subcontinent are pioneered by Horsfield and Moore (1857). Marshall and Nicéville (1882), Colonel Bingham (1905, 1907) and Talbot (1939, 1947) studied butterflies in India and documented them in 'The Fauna of British India'.

The state Odisha is situated at latitudes 17°49'-22°33' N and longitudes 81°27'-87°57' E in the eastern peninsula and experiences a tropical savanna climate with an average annual rainfall of 1450 mm to 1600 mm and an average annual temperature of 24.4 °C to 32.7 °C (India Meteorological Department, 2018: <https://metnet.imd.gov.in/imdnews/ar2018.pdf>; Forest & Environmental Department, 2020: <http://www.orienvis.nic.in/>). Presence of distinct phytogeographical regions such as the Eastern Ghats, the Deccan Plateau and the coastal plains with tropical forest cover and deciduous forests are appropriate habitats for faunal diversity (Reddy *et al.*, 2014). The faunistic works on butterflies of the state were pioneered by Taylor and Nicéville, where they prepared a list of butterfly species from Puri and Khurda district in 1888, followed by Crawford in 1921 from Sambalpur district. Annandale and Dover also recorded the butterfly species of Barkuda Island of Ganjam district in 1921 (Mandal and Nandi, 1983).

Though literature related to the butterfly diversity and abundance is available for the state (Mishra *et al.*, 2010; Mohapatra *et al.*, 2013; Priyamvada and Mohapatra, 2016; Boruah *et al.*, 2018; Payra *et al.*, 2019; Singh *et al.*, 2020), the species diversity and conservation in relation to their habitats in the rapidly urbanizing city of Bhubaneswar is yet to be explored. As part of long-term conservation strategies, local population dynamics as well as species diversity become extremely important since habitat fragmentation and loss of microhabitat pose threats to population persistence (Thomas *et al.*, 1992; Roy *et al.*, 2010; Fernandez-Chacon *et al.*, 2014; MacDonald *et al.*, 2018). In the past decade, topology and climate of the city have changed significantly due to increased urbanization, decreased vegetation, and a rise in temperature owing to the interplay of biotic and abiotic factors (Swain *et al.*, 2016; Gogoi *et al.*, 2019). The study aims to document the butterfly species diversity in relation to their habitats such as open scrub, garden habitat, urban habitat, urban park, urban forest, fragmented forest, and cropland in the city and its outskirts. The present study documented a list of 107 butterfly species out of which 17 species are new reports for this region and nine species are enlisted under the Wildlife (Protection) Act, 1972 (WPA, 1972).

Materials and Methods

Study site

The study was conducted in Bhubaneswar and its outskirts in Khordha district of Odisha, India, covering approximately 440 km². The study range was divided into 11 different study sites and maps indicating the same were created using ArcGIS software (version 10.3) and Google Earth (Figure 1). The detailed information about Global Positioning System (GPS) coordinates, elevation, and habitats for each study sites are provided (Table 1). The study range is predominated by seven types of habitats (Figure 2).

Survey and monitoring methods

A survey and documentation of the study sites were conducted from July 2018 to August 2020. For data collection, opportunistic survey and random sightings were used along with modified Pollard walk method (Pollard and Yates, 1992; Royer *et al.*, 1998; Wood and Gillman, 1998; Pellet *et al.*, 2012). All observations were carried out between 6:30 hrs to 11:30 hrs and 14:30 hrs to 17:30 hrs in good weathered conditions. During the study tenure, each study site was visited at least two times in each quarter of a year. Information about the coordinates and elevation of study sites were obtained by using Google's location services. Butterflies were photographed using Nikon gears (D3500 and D5300 DSLR cameras mounted with 18-55 mm and 70-300 mm Nikkor lenses), identified using field guides, books and the butterflies of India website (Kunte, 2000; Kehimkar, 2016; Smetacek, 2018; Butterflies of India, 2021: <https://www.ifoundbutterflies.org/>). The WPA, 1972 status of the butterflies were obtained from the database available at ENVIS Center on Wildlife &

Protected Areas (Scheduled Insect species, 2014: <http://wiienvis.nic.in/>). An entomological net was occasionally used and the butterflies were released unharmed to their natural habitat as soon as they were photographed. In this study none of the butterfly species were collected, euthanized or killed by any means. The host plants were identified and recorded as per the literature available (Karmakar *et al.*, 2018; Nitin *et al.*, 2018).

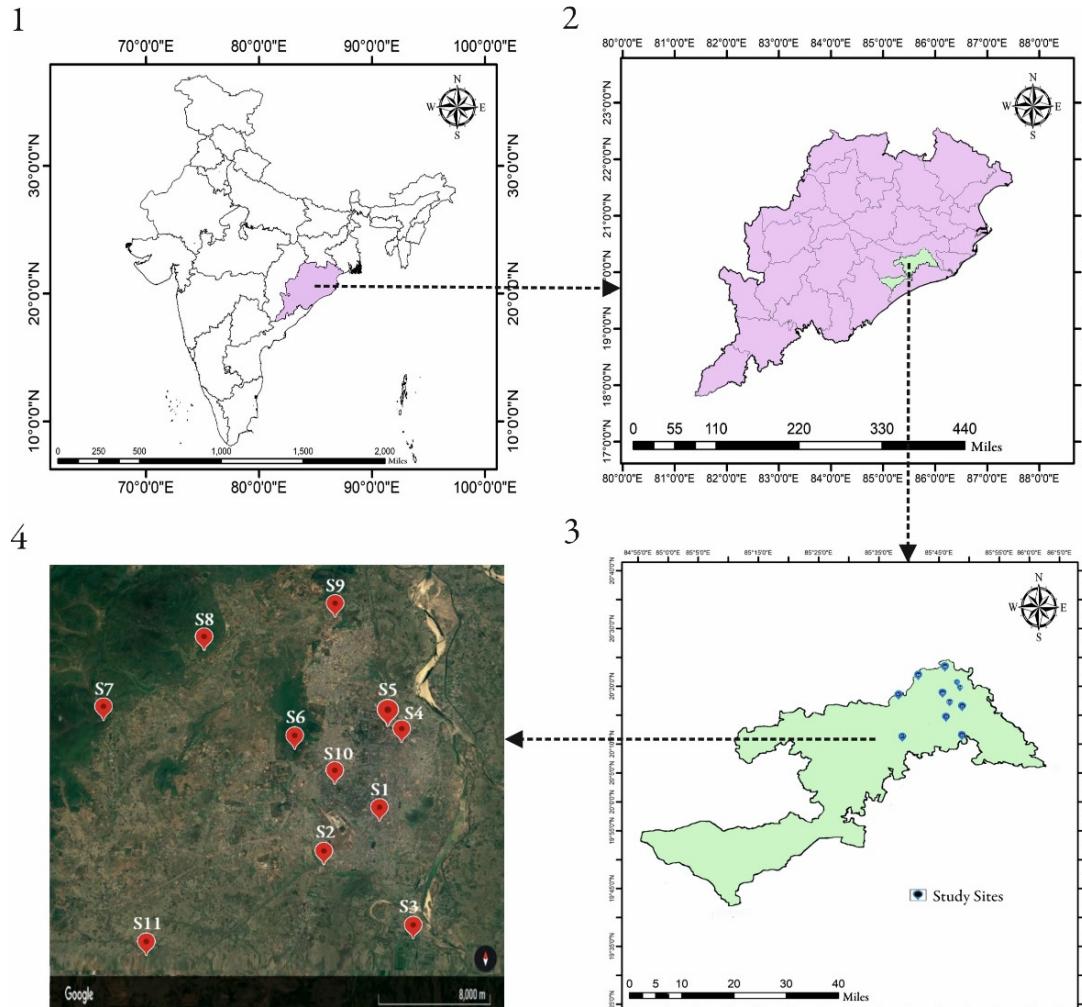


Figure 1. Maps indicating study sites: (1) Map of India indicating the state Odisha; (2) Map of the state Odisha indicating Khordha district; (3) Khordha district indicating the study sites of Bhubaneswar and its outskirts; (4) Google map indicating the topology of the study range with marked study sites
S1-S11 are the study sites

Table 1. Physiographic information about the study sites of Bhubaneswar and its outskirts

Sl. no.	Study site	Name of the study site	GPS coordinates	Elevation	Habitats
1	S1	B. J. B. College Campus	20.2506° N, 85.8411° E	35m/115ft	Open scrub, Garden habitat, Urban habitat, Urban park
2	S2	Old Town	20.2388° N, 85.8346° E	36m/118ft	Urban habitat having roadside plantation
3	S3	Dhauli Village	20.1972 °N, 85.8419° E	40m/131ft	Open scrub, Urban forest with water bodies
4	S4	Saheed Nagar	20.2910° N, 85.8456° E	43m/141ft	Urban habitat having roadside plantation
5	S5	Vani Vihar	20.3040° N, 85.8397° E	41m/135ft	Open scrub, Urban habitat, Urban forest
6	S6	Nayapalli	20.2997° N, 85.8060° E	58m/190ft	Open scrub, Garden habitat, Urban forest
7	S7	Ghangapatana and Deulipatana Villages	20.3088° N, 85.7308° E	46m/151ft	Open scrub, Fragmented forest having bamboo patches, Cropland
8	S8	Chandaka Village	20.3489° N, 85.7346° E	107m/351ft	Fragmented forest having bamboo patches, Cropland
9	S9	Raghunathpur	20.3958° N, 85.8260° E	23m/75ft	Open scrub, Fragmented forest, Cropland
10	S10	Surya Nagar	20.2698° N, 85.8131° E	40m/131ft	Urban habitat having roadside plantation
11	S11	Barunei	20.1611° N, 85.6461° E	130m/427ft	Open scrub, Urban forest, Fragmented forest

**Figure 2.** Types of habitats in the study range: (1) Open scrub; (2) Garden habitat; (3) Urban habitat; (4) Urban park; (5) Urban forest; (6) Fragmented forest; (7) Cropland

Statistical analysis

Sørensen's method was applied to find the similarity between number of species in different study sites and one-way Analysis of Variance (ANOVA) was used to analyse the dependence of relative distribution of species on habitat.

Sørensen's similarity index (β)

The Sørensen index is an indicator of similarity between two communities based on the number of common species shared by them. β can be defined as:

$$\beta = 2c / (s1 + s2)$$

where, s_1 = total number of species recorded in the first community, s_2 = number of species recorded in the second community, and c = number of species common to both communities.

The value of β lies between 0 and 1, wherein as the value approaches 0, the species overlap between the communities decrease and as the value moves towards 1, both the communities start having a greater number of shared species (Christopher, 2020). All the calculations were performed using Microsoft Excel (version 2019).

One-way ANOVA

It is used to determine the differences in the means of three or more independent groups. One-way ANOVA has been used in this study to establish a substantial relation between the variation in habitat and the species diversity by considering a null hypothesis (H_0) that the mean of family wise species diversity of each site is the same. The alternative hypothesis (H_1) is that at least one of the means is different. A significance level (α) of 0.05 implies a 5% risk of concluding that a difference exists when there is no actual difference. The variance ratio, F statistic (F stat), probability value (P-value), and critical value of F distribution (F crit) in the ANOVA table serve as the base to conclude the analysis. If $P < 0.05$ and the value of F stat is more than F crit, then the null hypothesis is rejected whereas if $P > 0.05$ and F stat is less than F crit, then the null hypothesis is accepted (Kim, 2017). In this study, one-way ANOVA was calculated using GraphPad Prism Software (version 5.0) and Microsoft Excel (version 2019).

Results

A total of 107 species of butterflies, belonging to 76 genera and five families (Papilionidae, Hesperiidae, Pieridae, Lycaenidae, and Nymphalidae) were recorded in this study whereas no butterflies from the families Hedylidae and Riodinidae were encountered during this study (Table 2). Information about host plants of the recorded butterfly species were enlisted (Table 3). Butterfly hierarchy was represented showing the number of species observed from each family (Figure 3). Photographs of each species categorised into their respective families were represented (Figure 4-8). Out of the total number of species recorded, nine species are legally protected in India under WPA, 1972, and 17 species are new reports for the city (Table 3). The highest number of species have been observed in Nymphalidae (34 species, 31.77%), followed by Lycaenidae (27 species, 25.23%), Hesperiidae (25 species, 23.36%), Pieridae (12 species, 11.21%), and Papilionidae (nine species, 8.41%) as illustrated (Figure 9A). The species to genus ratio (S/G) determines distribution of species among genera, and is calculated to be 3.000, 1.316, 1.500, 1.125, and 1.545 for Papilionidae, Hesperiidae, Pieridae, Lycaenidae, and Nymphalidae respectively (Figure 9B, Table 4). The family wise species distribution in different study sites showed that the highest number is observed in S8 (88 species) followed by S7 (77 species), S9 (74 species), S5 (63 species), S6 (48 species), S11 (43 species), S10 (42 species), S1 (36 species), S3 (34 species), S2 (31 species), and the lowest number is observed in S4 (27 species) as illustrated (Figure 9C). The distribution range of species number is found to be more scattered for Hesperiidae, Lycaenidae, and Nymphalidae as compared to Papilionidae and Pieridae (Figure 9D). According to the Sørensen's similarity index, a maximum value of 0.896 is observed between study sites S1 and S2 whereas a minimum value of 0.470 is observed between study sites S4 and S8 (Table 5). One-way ANOVA data shows that F stat value is 13.92, value of F crit is 2.55, and $P < 0.05$ for butterfly species in different families within the study range. Between the butterfly species among the study sites the result shows that F stat value is 2.34, value of F crit is 2.05, and $P < 0.05$. In both the cases $P < 0.05$ and the value of F stat is greater than the F crit value (Table 6).

Table 2. List of butterflies with detailed information recorded during this study

Sl. no.	Family/Sub Family	Common name	Scientific name	Authority	Adult wing span (in mm)	WPA, 1972	
Family Papilionidae: The swallow tails							
1	Sub Family: Papilioninae	Blue mormon	<i>Papilio polymnestor</i>	Cramer, 1775	120 - 150		
2		Common banded peacock	<i>Papilio crino</i>	Fabricius, 1793	80 - 100		
3		Common jay	<i>Graphium doson</i>	(C. & R. Felder, 1864)	70 - 80		
4		Common mime	<i>Papilio clytia</i>	Linnaeus, 1758	90 - 100	Sch I	
5		Common mormon	<i>Papilio polytes</i>	Linnaeus, 1758	90 - 100		
6		Common rose	<i>Pachliopta aristolochiae</i>	(Fabricius, 1775)	80 - 110		
7		Crimson rose	<i>Pachliopta hector</i>	(Linnaeus, 1758)	90 - 120	Sch I	
8		Lime	<i>Papilio demoleus</i>	Linnaeus, 1758	80 - 100		
9		Tailed jay	<i>Graphium agamemnon</i>	(Linnaeus, 1758)	85 - 100		
Family Hedyliidae: The Moth-butterflies. No butterflies were recorded during this study							
Family Hesperiidae: The skippers							
10	Sub Family: Coeliadinae	Common banded awl	<i>Hasora chromus</i>	(Cramer, [1780])	45 - 50		
11		Plain banded awl^	<i>Hasora vitta</i>	(Butler, 1870)	45 - 55	Sch IV	
12	Sub Family: Hesperiinae	Bush hopper	<i>Ampittia dioscorides</i>	(Fabricius, 1793)	22 - 28		
13		Chestnut bob	<i>Iambrix salsala</i>	(Moore, [1866])	26 - 30		
14		Common grass dart	<i>Taractrocera maevius</i>	(Fabricius, 1793)	22 - 28		
15		Common redeye	<i>Matapa aria</i>	(Moore, [1866])	40 - 55		
16		Continental swift^	<i>Parnara ganga</i>	(Evans, 1937)	30 - 32		
17		Dark palm dart	<i>Telicota ancilla</i>	(Moore, 1878)	33 - 36		
18		Grass demon	<i>Udaspes folus</i>	(Cramer, [1775])	40 - 48		
19		Indian palm bob	<i>Suastus gremius</i>	(Fabricius, 1798)	32 - 45		
20		Large branded swift^	<i>Pelopidas subochracea</i>	(Moore, 1878)	38 - 42		
21		Lesser rice swift^	<i>Borbo bevani</i>	(Moore, 1878)	32 - 36		
22		Little branded swift^	<i>Pelopidas agna</i>	(Moore, [1866])	30 - 38		
23		Pale palm dart^	<i>Telicota colon</i>	(Fabricius, 1775)	30 - 36		
24		Plain palm dart^	<i>Cephalenes acalle</i>	(Höpffer, 1874)	45		
25		Purple redeye^	<i>Matapa purpurascens</i>	Elwes & Edwards, 1897	48 - 54		
26		Rice swift	<i>Borbo cinnara</i>	(Wallace, 1866)	30 - 36		
27		Small branded swift	<i>Pelopidas mathias</i>	(Fabricius, 1798)	32 - 38		
28		Tree flitter	<i>Hyarotis adrastus</i>	(Stoll, [1780])	38 - 48	Sch IV	
29		Wax dart	<i>Cupitha purreea</i>	(Moore, 1877)	28 - 33		
30	Sub Family: Pyrginae	Common small flat	<i>Sarangesa dasahara</i>	(Moore, [1866])	26 - 35		
31		Golden angle	<i>Caprona ransonnetti</i>	(R. Felder, 1868)	35 - 45		
32		Indian skipper	<i>Spialia galba</i>	(Fabricius, 1793)	22 - 27		

33		Tricolour pied flat^	<i>Coladenia indrani</i>	(Moore, [1866])	40 - 46		
34		Water snow flat^	<i>Tagiades litigiosa</i>	Möschler, 1878	37 - 44		
Family Pieridae: The whites and yellows							
35	Sub Family: Coliadinae	Changeable grass yellow^	<i>Eurema simulatrix</i>	(Staudinger, 1891)	40 - 50		
36		Common emigrant	<i>Catopsilia pomona</i>	(Fabricius, 1775)	55 - 80		
37		Common grass yellow	<i>Eurema hecabe</i>	(Linnaeus, 1758)	40 - 50		
38		Mottled emigrant	<i>Catopsilia pyranthe</i>	(Linnaeus, 1758)	50 - 70		
39		One-spot grass yellow	<i>Eurema andersonii</i>	(Moore, 1886)	38 - 45		
40		Three-spot grass yellow	<i>Eurema blanda</i>	(Boisduval, 1836)	40 - 45		
41	Sub Family: Pierinae	Black veined albatross	<i>Appias olferna</i>	Swinhoe, 1890	55 - 65		
42		Common gull	<i>Cepora nerissa</i>	(Fabricius, 1775)	40 - 65		
43		Common jezebel	<i>Delias eucharis</i>	(Drury, 1773)	66 - 83		
44		Common wanderer	<i>Pareronia hippia</i>	(Fabricius, 1787)	65 - 80		
45		Psyche	<i>Leptosia nina</i>	(Fabricius, 1793)	35 - 50		
46		Yellow orange-tip	<i>Ixias pyrene</i>	(Linnaeus, 1764)	50 - 70		
Family Riodinidae: The Metal-markers. No butterflies were recorded during this study							
Family Lycaenidae: The gossamer-winged butterflies							
47	Sub Family: Curetinae	Indian sunbeam	<i>Curetis thetis</i>	(Drury, [1773])	40 - 48		
48	Sub Family: Polyommatiniae	Black-spotted grass jewel^	<i>Freyeria putli</i>	(Kollar, [1844])	12 - 18		
49		Common cerulean	<i>Jamides celeno</i>	(Cramer, [1775])	27 - 40		
50		Common hedge blue	<i>Acytolepis puspa</i>	(Horsfield, [1828])	28 - 35		
51		Common lineblue	<i>Prosotas nora</i>	(Felder, 1860)	18 - 25		
52		Common pierrot	<i>Castalius rosimon</i>	(Fabricius, 1775)	24 - 34		
53		Dark cerulean	<i>Jamides bochus</i>	(Stoll, [1782])	25 - 34		
54		Dark grass blue	<i>Zizeeria karsandra</i>	(Moore, 1865)	18 - 24		
55		Forget-me-not	<i>Catochrysops strabo</i>	(Fabricius, 1793)	25 - 35		
56		Gram blue	<i>Euchrysops cnejus</i>	(Fabricius, 1798)	25 - 33	Sch II	
57		Lesser grass blue	<i>Zizina otis</i>	(Fabricius, 1787)	19 - 26		
58		Lime blue	<i>Chilades lajus</i>	(Stoll, [1780])	26 - 30		
59		Little tiger pierrot^	<i>Tarucus balkanica</i>	(Freyer, 1844)	21 - 24		
60		Pale grass blue	<i>Pseudozizeeria maha</i>	(Kollar, [1844])	26 - 30		
61		Pea blue	<i>Lampides boeticus</i>	(Linnaeus, 1767)	24 - 36	Sch II	
62		Plains cupid	<i>Luthrodes pandava</i>	(Horsfield, 1829)	25 - 33		
63		Pointed ciliate blue	<i>Anthene lycaenina</i>	(Felder, 1868)	24 - 29	Sch II	
64		Quaker	<i>Neopithecops zalmora</i>	(Butler, [1870])	16 - 30		
65		Silver forget-me-not	<i>Catochrysops panormus</i>	(Felder, 1860)	25 - 35		

66		Striped pierrot	<i>Tarucus nara</i>	(Kollar, 1848)	16 - 28	
67		Tiny grass blue	<i>Zizula hylax</i>	(Fabricius, 1775)	16 - 24	
68	Sub Family: Theclinae	Common silverline	<i>Spindasis vulcanus</i>	(Fabricius, 1775)	26 - 34	Sch II
69		Falcate oakblue^	<i>Mahathala ameria</i>	(Hewitson, 1862)	38 - 42	
70		Monkey puzzle	<i>Rathinda amor</i>	(Fabricius, 1775)	26 - 28	
71		Purple leaf blue	<i>Amblypodia anita</i>	Hewitson, 1862	45 - 52	
72		Slate flash	<i>Rapala manea</i>	(Hewitson, 1863)	30 - 33	
73		Yamfly	<i>Loxura atymnus</i>	(Stoll, 1780)	36 - 40	
Family Nymphalidae: The brush-footed butterflies						
74	Sub Family: Biblidinae	Angled castor	<i>Ariadne ariadne</i>	(Moore, 1884)	45 - 60	Sch I
75		Common castor	<i>Ariadne merione</i>	(Cramer, [1777])	45 - 60	
76	Sub Family: Charaxinae	Common nawab	<i>Polyura athamas</i>	(Drury, 1773)	60 - 75	
77	Sub Family: Danainae	Common crow	<i>Euploea core</i>	(Cramer, [1780])	85 - 95	
78		Blue tiger	<i>Tirumala limniace</i>	(Cramer, [1775])	90 - 100	
79		Glossy tiger	<i>Parantica aglea</i>	(Stoll, [1782])	70 - 85	
80		Plain tiger	<i>Danaus chrysippus</i>	(Linnaeus, 1758)	70 - 80	
81		Striped tiger	<i>Danaus genutia</i>	(Cramer, [1779])	72 - 100	
82	Sub Family: Heliconiinae	Common leopard	<i>Phalanta phalantha</i>	Drury, 1773	50 - 60	
83		Tawny coster	<i>Acraea terpsicore</i>	(Linnaeus, 1758)	50 - 65	
84	Sub Family: Limenitidinae	Baronet	<i>Symphaedra naïs</i>	(Forster, 1771)	60 - 70	
85		Chestnut-streaked sailer	<i>Neptis jumbah</i>	Moore, [1858]	60 - 70	
86		Commander	<i>Moduza procris</i>	(Cramer, [1777])	60 - 75	
87		Common baron	<i>Euthalia aconthea</i>	(Cramer, [1777])	55 - 80	
88		Common lascar	<i>Pantoporia hordonia</i>	(Stoll, [1790])	45 - 50	
89		Common sailer	<i>Neptis hylas</i>	(Linnaeus, 1758)	50 - 60	
90	Sub Family: Morphinae	Common duffer^	<i>Discophora sondaica</i>	Boisduval, 1836	80 - 90	
91	Sub Family: Nymphalinae	Blue pansy	<i>Junonia orithya</i>	(Linnaeus, 1758)	45 - 60	Sch I
92		Chocolate pansy	<i>Junonia iphita</i>	(Cramer, [1779])	55 - 80	
93		Danaid eggfly	<i>Hypolimnas misippus</i>	(Linnaeus, 1764)	70 - 85	
94		Great eggfly	<i>Hypolimnas bolina</i>	(Linnaeus, 1758)	70 - 110	
95		Grey pansy	<i>Junonia atlites</i>	(Linnaeus, 1763)	55 - 60	
96		Lemon pansy	<i>Junonia lemonias</i>	(Linnaeus, 1758)	40 - 60	
97		Painted lady^d	<i>Vanessa cardui</i>	(Linnaeus, 1758)	55 - 70	
98		Peacock pansy	<i>Junonia almana</i>	(Linnaeus, 1758)	60 - 65	
99	Sub Family: Satyrinae	Bamboo tree brown	<i>Lethe europa</i>	(Fabricius, 1787)	65 - 75	
100		Common bushbrown	<i>Mycalesis perseus</i>	(Fabricius, 1775)	38 - 55	
101		Common evening brown	<i>Melanitis leda</i>	(Linnaeus, 1758)	60 - 80	
102		Common four-ring	<i>Ypthima huebneri</i>	Kirby, 1871	30 - 40	

103		Common palmfly	<i>Elymnias hypermnestra</i>	(Linnaeus, 1763)	60 - 80	
104		Common three-ring [^]	<i>Ypthima asterope</i>	(Klug, 1832)	30 - 37	
105		Dark-branded bushbrown	<i>Mycalesis mineus</i>	(Linnaeus, 1858)	40 - 50	
106		Dark evening brown	<i>Melanitis phedima</i>	(Cramer, [1780])	60 - 70	
107		White four-ring	<i>Ypthima ceylonica</i>	Hewitson, [1865]	30 - 35	

Species marked with (^) reported for the first time from Bhubaneswar. Species marked with (°) is long range migratory species. mm, millimeter; Sch, Scheduled species; WPA, 1972, The Wildlife (Protection) Act, 1972.

Table 3. Host plant list of the recorded butterfly species

Sl. no.	Butterfly species	Host plant		
		Family	Common name	Scientific name
1	<i>Papilio polymnestor</i>	i) Rubiaceae ii) Rutaceae	i) Jungle geranium ii) Pomelo	i) <i>Ixora coccinea</i> ii) <i>Citrus maxima</i>
2	<i>Papilio crino</i>	Rutaceae	a) Lemon b) East Indian satinwood	a) <i>Citrus limon</i> b) <i>Chloroxylon swietenia</i>
3	<i>Graphium doson</i>	i) Annonaceae ii) Magnoliaceae	i) a) Pond apple b) Hoom c) False Ashoka/Buddha tree ii) a) Southern Magnolia/Him champa b) Champak/Champa	i) a) <i>Annona glabra</i> b) <i>Miliusa tomentosa</i> c) <i>Polyalthia longifolia</i> ii) a) <i>Magnolia grandiflora</i> b) <i>Michelia champaca</i>
4	<i>Papilio clytia</i>	Lauraceae	a) Camphor tree/Camphorwood b) Indian bay leaf	a) <i>Cinnamomum camphora</i> b) <i>Cinnamomum tamala</i>
5	<i>Papilio polytes</i>	Rutaceae	a) Bael/Wood apple b) Curry leaf tree c) Citron/Galgal d) Persian lime	a) <i>Aegle marmelos</i> b) <i>Murraya koenigii</i> c) <i>Citrus medica</i> d) <i>Citrus latifolia</i>
6	<i>Pachliopta aristolochiae</i>	Aristolochiaceae	a) Indian birthwort b) Calico flower/Pipe vine c) Chakrani	a) <i>Aristolochia indica</i> b) <i>Aristolochia littoralis</i> c) <i>Thottea siliquosa</i>
7	<i>Pachliopta hector</i>	Aristolochiaceae	a) Indian birthwort b) Calico flower/Pipe vine	a) <i>Aristolochia indica</i> b) <i>Aristolochia littoralis</i>
8	<i>Papilio demoleus</i>	i) Fabaceae ii) Rhamnaceae iii) Rutaceae	i) Babchi/Kushtanashini ii) Jujube/Indian plum iii) a) Bael/Wood apple b) East Indian Satinwood c) Citron/Galgal d) Elephant-apple/Kaith e) Curry leaf tree	i) <i>Psoralcea corylifolia</i> ii) <i>Ziziphus mauritiana</i> iii) a) <i>Aegle marmelos</i> b) <i>Chloroxylon swietenia</i> c) <i>Citrus medica</i> d) <i>Limonia acidissima</i> e) <i>Muraya koenigii</i>
9	<i>Graphium agamemnon</i>	i) Annonaceae ii) Magnoliaceae	i) a) Pond apple b) Hoom c) False Ashoka/Buddha tree d) Corky debbar tree ii) Champak/Champa	i) a) <i>Annona glabera</i> b) <i>Miliusa tomentosa</i> c) <i>Polyalthia longifolia</i> d) <i>Polyalthia suberosa</i> ii) <i>Michelia champaca</i>
10	<i>Hasora chromus</i>	Fabaceae	Karanja/Indian beech	<i>Millettia pinnata</i>
11	<i>Hasora vitra</i>	Fabaceae	a) Arge-leaf pongam b) Ardha/Swardhang	a) <i>Millettia extensa</i> b) <i>Endosamara racemose</i>
12	<i>Ampittia dioscorides</i>	Poaceae	Asian rice	<i>Oryza sativa</i>
13	<i>Iambrix salsala</i>	Poaceae	a) Indian thorny bamboo b) Para grass/Buffalo grass	a) <i>Bambusa arundinacea</i> b) <i>Bracharia mutica</i>
14	<i>Taractrocera maevius</i>	Poaceae	Asian rice	<i>Oryza sativa</i>

15	<i>Matapa aria</i>	Poaceae	Indian thorny bamboo	<i>Bambusa arundinaceae</i>
16	<i>Parnara ganga</i>	Poaceae	Asian rice	<i>Oryza sativa</i>
17	<i>Telicota ancilla</i>	Poaceae	a) Sugarcanes b) Common bamboo	a) <i>Saccharum sp.</i> b) <i>Bambusa vulgaris</i>
18	<i>Udaspes folus</i>	i) Costaceae ii) Zingiberaceae	i) Crepe ginger ii) Black Turmeric	i) <i>Costus speciosus</i> ii) <i>Curcuma caesia</i>
19	<i>Suastus gremius</i>	Arecaceae	a) Queen palm b) Coconut tree c) Golden cane palm d) Silver date palm/Indian date	a) <i>Arecastrum romanizffianum</i> b) <i>Cocos nucifera</i> c) <i>Dypsis lutescens</i> d) <i>Phoenix sylvestris</i>
20	<i>Pelopidas subochracea</i>	Poaceae	Carpet grass	<i>Axonopus compressus</i>
21	<i>Borbo bevani</i>	Poaceae	a) Sugarcanes b) Cogon grass	a) <i>Saccharum sp.</i> b) <i>Imperata cylindrica</i>
22	<i>Pelopidas agna</i>	Poaceae	a) Carpet grass b) Fountain grass	a) <i>Axonopus compressus</i> b) <i>Pennisetum sp.</i>
23	<i>Telicota colon</i>	Poaceae	Sugarcane	<i>Saccharum officinarum</i>
24	<i>Cephrenes acalle</i>	Arecaceae	a) Coconut tree b) Palmyra palm	a) <i>Cocos nucifera</i> b) <i>Borassus flabellifer</i>
25	<i>Matapa purpurascens</i>	Asteraceae	Siam weed/Tibra gandha	<i>Chromolaena odorata</i>
26	<i>Borbo cinnara</i>	Poaceae	a) Para grass/Buffalo grass b) Asian rice c) Johnson grass d) Jowar	a) <i>Brachiaria mutica</i> b) <i>Oryza sativa</i> c) <i>Sorghum halepense</i> d) <i>Sorghum nitidum</i>
27	<i>Pelopidas mathias</i>	Poaceae	a) Sugarcane b) Asian rice	a) <i>Saccharum officinarum</i> b) <i>Oryza sativa</i>
28	<i>Hyarotis adrastus</i>	Arecaceae	Rattan palms	<i>Calamus sp.</i>
29	<i>Cupitha purreea</i>	Combretaceae	a) Rangoon creeper b) Bahada	a) <i>Combretum indicum</i> b) <i>Terminalia bellirica</i>
30	<i>Sarangesa dasahara</i>	Acanthaceae	a) Violet asystasia b) Spiny lepidagathis	a) <i>Asystasia dalzelliana</i> b) <i>Lepidagathis cuspidata</i>
31	<i>Caprona ransonnetti</i>	Malvaceae	Indian screw tree	<i>Helicteres isora</i>
32	<i>Spialia galba</i>	i) Malvaceae ii) Sterculiaceae	i) a) Common wireweed b) Chocolateweed ii) Sleepy morning	i) a) <i>Sida acuta</i> b) <i>Melochia corchorifolia</i> ii) <i>Waltheria indica</i>
33	<i>Coladenia indrani</i>	i) Fabaceae ii) Malvaceae	a) Bidi leaf tree ii) Diamond burbark	i) <i>Bauhinia racemosa</i> ii) <i>Triumfetta rhomboidea</i>
34	<i>Tagiades litigiosa</i>	i) Dioscoreaceae ii) Dipterocarpaceae	i) Bana alu/Pita alu ii) Taloora lac tree	i) <i>Dioscorea wallichii</i> ii) <i>Shorea roxburghii</i>
35	<i>Eurema simulatrix</i>	Fabaceae	Golden shower/Indian laburnum	<i>Cassia fistula</i>
36	<i>Catopsilia pomona</i>	i) Apocynaceae ii) Fabaceae	i) Conkerberry/Bush plum ii) a) Bidi leaf tree b) Flame-of-the-forest/Palash c) Golden Shower/Indian laburnum d) Vegetable Hummingbird	i) <i>Carissa spinarum</i> ii) a) <i>Bauhinia racemosa</i> b) <i>Butea monosperma</i> c) <i>Cassia fistula</i> d) <i>Sesbania grandiflora</i>
37	<i>Eurema hecabe</i>	Fabaceae	a) Rain tree/Monkey pod b) Peacock flower/Red bird of paradise c) Red powder puff d) Golden shower/Indian laburnum	a) <i>Albizia saman</i> b) <i>Caesalpinia pulcherrima</i> c) <i>Calliandra haematocephala</i> d) <i>Cassia fistula</i>
38	<i>Catopsilia pyranthe</i>	i) Apocynaceae ii) Fabaceae	i) Conkerberry/Bush plum ii) Golden shower/Indian laburnum	i) <i>Carissa spinarum</i> ii) <i>Cassia fistula</i>
39	<i>Eurema andersonii</i>	Rhamnaceae	Toothed-leaf red creeper	<i>Ventilago denticulata</i>
40	<i>Eurema blanda</i>	Fabaceae	Purple orchid tree	<i>Bauhinia purpurea</i>
41	<i>Appias olferna</i>	Capparaceae	Fringed spider flower	<i>Cleome rutidosperma</i>

42	<i>Cepora nerissa</i>	Capparaceae	a) Caper shrubs/Caperbushes b) Ceylon caper	a) <i>Capparis sp.</i> b) <i>Capparis zeylanica</i>
43	<i>Delias eucharis</i>	i) Loranthaceae ii) Meliaceae	i) Honey suckle mistletoe ii) Neem	i) <i>Dendrophthoe falcata</i> ii) <i>Azadirachta indica</i>
44	<i>Pareronia hippia</i>	Capparaceae	a) Caper shrubs/Caperbushes b) Ceylon caper	a) <i>Capparis sp.</i> b) <i>Capparis zeylanica</i>
45	<i>Leptosia nina</i>	Capparaceae	a) Fringed spiderflower/Purple cleome b) Asian spiderflower/Tick weed c) Caper shrubs/Caper bushes	a) <i>Cleome rutidosperma</i> b) <i>Cleome viscosa</i> c) <i>Capparis sp.</i>
46	<i>Ixias pyrene</i>	Capparaceae	a) Spreading caper b) Wild caper bush	a) <i>Capparis divaricata</i> b) <i>Capparis sepiaria</i>
47	<i>Curetis thetis</i>	Fabaceae	a) Jequirity bean/Rosary pea b) Flame-of-the-forest/Palash c) Karanja/Indian beech	a) <i>Abrus precatorius</i> b) <i>Butea monosperma</i> d) <i>Millettia pinnata</i>
48	<i>Freyeria putli</i>	i) Asteraceae ii) Boraginaceae iii) Fabaceae	i) Tridax daisy ii) Indian heliotrope iii) Narrow-leaved indigo	i) <i>Tridax procumbens</i> ii) <i>Heliotropium indicum</i> iii) <i>Indigofera linifolia</i>
49	<i>Jamides celeno</i>	i) Fabaceae ii) Zingiberaceae	i) a) Ashoka tree b) Mung bean/Green gram ii) Green/True cardamom	i) a) <i>Saraca asoca</i> b) <i>Vigna radiata</i> ii) <i>Elettaria cardamomum</i>
50	<i>Acytolepis puspa</i>	i) Fabaceae ii) Phyllanthaceae iii) Sapindaceae	i) Mexican lilac ii) Spinous kino tree iii) Kurpa	i) <i>Gliricidia sepium</i> ii) <i>Bridelia retusa</i> iii) <i>Lepisanthes tetraphylla</i>
51	<i>Prosotas nora</i>	i) Euphorbiaceae ii) Mimosaceae iii) Sapindaceae	i) Kamala/Kumkum tree ii) Twisted acacia iii) Indian allophylus/Tit berry	i) <i>Mallotus philippensis</i> ii) <i>Acacia torta</i> iii) <i>Allophylus cobbe</i>
52	<i>Castalius rosimon</i>	Rhamnaceae	a) Jujube/Red date b) Jhar beri	a) <i>Ziziphus zuzuba</i> b) <i>Ziziphus nummularia</i>
53	<i>Jamides bochus</i>	Fabaceae	a) Ashoka tree b) Burma ironwood	a) <i>Saraca asoca</i> b) <i>Xylia xylocarpa</i>
54	<i>Zizeeria karsandra</i>	i) Amaranthaceae ii) Molluginaceae iii) Polygonaceae iv) Zygophyllaceae	i) Spiny amaranthus ii) Lotus sweetjuice iii) Common knotweed iv) Bindii	i) <i>Amaranthus spinosus</i> ii) <i>Glinus lotoides</i> iii) <i>Polygonum plebeium</i> iv) <i>Tribulus terrestris</i>
55	<i>Catochrysops strabo</i>	i) Fabaceae ii) Sapindaceae	i) a) Asian tick trefoil b) Karanja/Indian beech c) Common tephrosia ii) Indian Allophylus/Tit berry	i) a) <i>Desmodium heterocarpum</i> b) <i>Millettia pinnata</i> c) <i>Tephrosia purpurea</i> ii) <i>Allophylus cobbe</i>
56	<i>Euchrysops cnejus</i>	Fabaceae	a) Flame-of-the-forest/Palash b) Sword bean	a) <i>Butea monosperma</i> b) <i>Canavalia gladiata</i>
57	<i>Zizina otis</i>	Fabaceae	a) Asian tick trefoil b) Chinchan/Kansevari c) Three-leaf indigo	a) <i>Desmodium heterophyllum</i> b) <i>Sesbania bispinosa</i> c) <i>Indigofera trifoliata</i>
58	<i>Chilades lajus</i>	Rutaceae	a) Sweet lemon b) Lemon c) Pomelo d) Kamini/Orange jasmine	a) <i>Citrus limetta</i> b) <i>Citrus limon</i> c) <i>Citrus maxima</i> d) <i>Murraya paniculata</i>
59	<i>Tarucus balkanica</i>	Rhamnaceae	a) Jujuba/Red date b) Jhar beri	a) <i>Ziziphus jujuba</i> b) <i>Ziziphus nummularia</i>
60	<i>Pseudozizeeria maha</i>	Oxalidaceae	Creeping wood sorrel	<i>Oxalis corniculata</i>
61	<i>Lampides boeticus</i>	Fabaceae	a) Flame-of-the-forest/Palash b) Garden pea	a) <i>Butea monosperma</i> b) <i>Pisum sativum</i>

62	<i>Luthrodes pandava</i>	i) Cycadaceae ii) Fabaceae	i) a) Queen sago b) Nepal cycas/Thaljimura ii) a) Malu creeper/Adda leaf b) Orchid tree c) Sword bean d) Ashoka tree	i) a) <i>Cycas circinalis</i> b) <i>Cycas pectinata</i> c) <i>Cycas revoluta</i> ii) a) <i>Bauhinia vahlii</i> b) <i>Bauhinia variegata</i> c) <i>Canavalia gladiata</i> d) <i>Saraca asoca</i>
63	<i>Anthene lycaenina</i>	i) Anacardiaceae ii) Euphorbiaceae iii) Fabaceae	i) Chironji/Charoli ii) Putranjiva iii) a) Rosewood/Indian palisandre b) Shikakai	i) <i>Buchanania lanza</i> ii) <i>Drypetes roxburghii</i> iii) a) <i>Dalbergia latifolia</i> b) <i>Acacia concinna</i>
64	<i>Neopithecops zalmora</i>	Rutaceae	Orange berry/Gin berry	<i>Glycosmis pentaphylla</i>
65	<i>Catochrysops panormus</i>	Fabaceae	Large leaf fleminga	<i>Flemingia macrophylla</i>
66	<i>Tarucus nara</i>	Rhamnaceae	a) Jujuba/Red date b) Jhar beri	a) <i>Ziziphus jujuba</i> b) <i>Ziziphus nummularia</i>
67	<i>Zizula hylax</i>	i) Acanthaceae ii) Verbenaceae	i) a) Temple plant/Marsh barbel b) Desert petunia ii) Raimuniya	i) a) <i>Hygrophila auriculata</i> b) <i>Ruellia simplex</i> ii) <i>Lantana camara</i>
68	<i>Spindasis vulcanus</i>	i) Apocynaceae ii) Dioscoreaceae iii) Fabaceae iv) Rhamnaceae	i) Bengal currant/Karanda ii) Bana alu/Pita alu iii) Golden shower/Indian laburnum iv) Jujube/Red date	i) <i>Carissa carandas</i> ii) <i>Dioscorea wallichii</i> iii) <i>Cassia fistula</i> iv) <i>Ziziphus zuzuba</i>
69	<i>Mahathala ameria</i>	Euphorbiaceae	Climbing liana	<i>Mallotus repandus</i>
70	<i>Rathinda amor</i>	i) Anacardiaceae ii) Lecythidaceae iii) Rubiaceae iv) Sapindaceae	i) Mango ii) Wild guava iii) Jungle geranium iv) Litchi	i) <i>Mangifera indica</i> ii) <i>Careya arborea</i> iii) <i>Ixora coccinea</i> iv) <i>Litchi chinensis</i>
71	<i>Amblypodia anita</i>	Olacaceae	South Asian olax	<i>Olax imbricata</i>
72	<i>Rapala manca</i>	i) Combretaceae ii) Lamiaceae iii) Verbenaceae	i) Rangoon creeper ii) Bhat/Hill glory flower iii) Raimuniya	i) <i>Combretum indicum</i> ii) <i>Clerodendrum infortunatum</i> iii) <i>Lantana camara</i>
73	<i>Loxura atymnus</i>	i) Dioscoreaceae ii) Smilacaceae	i) Five-leaf yam ii) Kumarika	i) <i>Dioscorea pentaphylla</i> ii) <i>Smilax zeylanica</i>
74	<i>Ariadne ariadne</i>	Euphorbiaceae	a) Castor bean/Castor b) Indian stinging nettle	a) <i>Ricinus communis</i> b) <i>Tragia involucrata</i>
75	<i>Ariadne merione</i>	Euphorbiaceae	a) Castor bean/Castor b) Indian stinging nettle	a) <i>Ricinus communis</i> b) <i>Tragia involucrata</i>
76	<i>Polyura athamas</i>	Fabaceae	a) Twisted acacia b) Royal poinciana/Gulmohar c) Woman's tongue tree	a) <i>Acacia torta</i> b) <i>Delonix regia</i> c) <i>Albizia lebbeck</i>
77	<i>Euploea core</i>	i) Apocynaceae ii) Moraceae iii) Sapotaceae	i) a) Desert rose b) Bengal currant/Karanda c) Oleander ii) a) Indian rock fig/Rock peepal b) Indian banyan c) Indian fig tree/Gular iii) Spanish cherry	i) a) <i>Adenium obesum</i> b) <i>Carissa carandas</i> c) <i>Nerium oleander</i> ii) a) <i>Ficus arnottiana</i> b) <i>Ficus benghalensis</i> c) <i>Ficus racemosa</i> iii) <i>Mimusops elengi</i>
78	<i>Tirumala limniace</i>	Apocynaceae	a) Apple of sodom/Arak b) Tropical milkweed/Bloodflower c) Bread flower	a) <i>Calotropis procera</i> b) <i>Asclepias curassavica</i> c) <i>Vallaris solanacea</i>
79	<i>Parantica aglea</i>	Apocynaceae	a) Crown flower b) Bulbous ceropogia	a) <i>Calotropis gigantea</i> b) <i>Ceropogia bulbosa</i>

80	<i>Danaus chrysippus</i>	Apocynaceae	a) Crown flower b) Tropical milkweed/Bloodflower c) Balloon plant	a) <i>Calotropis gigantea</i> b) <i>Asclepias curassavica</i> c) <i>Gomphocarpus physocarpus</i>
81	<i>Danaus genutia</i>	Apocynaceae	Tropical milkweed/Bloodflower	<i>Asclepias curassavica</i>
82	<i>Phalanta phalantha</i>	Salicaceae	a) Governor's plum/Batoko plum b) Indian coffee plum c) Mountain sweet thorn	a) <i>Flacourtie indica</i> b) <i>Flacourtie jangomas</i> c) <i>Flacourtie montana</i>
83	<i>Acraea terpsicore</i>	i) Passifloraceae ii) Violaceae	i) a) Stinking passionflower b) White buttercup ii) Spade flower	i) a) <i>Passiflora foetida</i> b) <i>Turnera subulata</i> ii) <i>Hybanthus enneaspermus</i>
84	<i>Symphaedra nais</i>	i) Ebenaceae ii) Malvaceae	i) Coromandel ebony/Tendu ii) Phalsa	i) <i>Diospyros melanoxylon</i> ii) <i>Grewia asiatica</i>
85	<i>Neptis jumbah</i>	Fabaceae	a) Golden shower/Indian laburnum b) Indian rosewood	a) <i>Cassia fistula</i> b) <i>Dalbergia latifolia</i>
86	<i>Moduza procris</i>	i) Capparaceae ii) Rubiaceae	i) Indian cadaba ii) a) Ashanti blood/Red flag bush b) Dhobi tree/Mussaenda c) Burflower-tree/Kadamb	i) <i>Cadaba fruticosa</i> ii) a) <i>Mussaenda erythrophylla</i> b) <i>Mussaenda frondosa</i> c) <i>Neolamarckia cadamba</i>
87	<i>Euthalia aconthea</i>	Anacardiaceae	a) Cashew b) Mango	a) <i>Anacardium occidentale</i> b) <i>Mangifera indica</i>
88	<i>Pantoporia hordonia</i>	Fabaceae	Kali siris	<i>Albizia odoratissima</i>
89	<i>Neptis hylas</i>	i) Fabaceae ii) Malvaceae iii) Salicaceae	i) Butterfly pea ii) Cotton tree iii) Indian willow	i) <i>Centrosema pubescens</i> ii) <i>Bombax ceiba</i> iii) <i>Salix tetrasperma</i>
90	<i>Discophora sondaica</i>	Poaceae	Bamboo	<i>Bambusa sp.</i>
91	<i>Junonia orithya</i>	i) Acanthaceae ii) Moraceae	i) a) Philippine violet b) Water willow c) Roundleaf kariyat ii) White mulberry	i) a) <i>Barleria cristata</i> b) <i>Justicia procumbens</i> c) <i>Andrographis serpuliflolia</i> ii) <i>Morus alba</i>
92	<i>Junonia iphita</i>	Acanthaceae	a) Philippine violet b) Marsh barbel/Kokilaksha	a) <i>Barleria cristata</i> b) <i>Hygrophila auriculata</i>
93	<i>Hypolimnas misippus</i>	i) Convolvulaceae ii) Malvaceae	i) Pink morning glory ii) China rose	i) <i>Ipomoea carnea</i> ii) <i>Hibiscus rosa-sinensis</i>
94	<i>Hypolimnas bolina</i>	Urticaceae	Hen's nettle	<i>Laportea interrupta</i>
95	<i>Junonia atlites</i>	Acanthaceae	a) Philippine violet b) Marsh barbel/Kokilaksha	a) <i>Barleria cristata</i> b) <i>Hygrophila auriculata</i>
96	<i>Junonia lemonias</i>	Acanthaceae	a) Philippine violet b) Water willow c) Roundleaf kariyat	a) <i>Barleria cristata</i> b) <i>Justicia procumbens</i> c) <i>Andrographis serpuliflolia</i>
97	<i>Vanessa cardui</i>	i) Asteraceae ii) Fabaceae iii) Papaveraceae	i) Coatbuttons/Tridax daisy ii) Two-leaf zornia iii) Mexican prickly poppy	i) <i>Tridax procumbens</i> ii) <i>Zornia diphylla</i> iii) <i>Argemone mexicana</i>
98	<i>Junonia almana</i>	Acanthaceae	a) Philippine violet b) Marsh barbel/Kokilaksha	a) <i>Barleria cristata</i> b) <i>Hygrophila auriculata</i>
99	<i>Lethe europa</i>	Poaceae	Bamboo	<i>Bambusa sp.</i>
100	<i>Mycalesis perseus</i>	Poaceae	a) Running mountain grass b) Barnyard grass/Cockspur grass	a) <i>Oplismenus compositus</i> b) <i>Echinochloa sp.</i>
101	<i>Melanitis leda</i>	Poaceae	a) Maize/Corn b) Indian thorny bamboo c) Indian goosegrass	a) <i>Zea mays</i> b) <i>Bambusa arundinacea</i> c) <i>Eleusine indica</i>
102	<i>Ypthima huebneri</i>	Poaceae	Indian goosegrass	<i>Eleusine indica</i>
103	<i>Elymnias hypermnestra</i>	Arecaceae	a) Areca palm b) Golden cane palm c) Silver date palm/Indian date d) Macarthur palm	a) <i>Areca catechu</i> b) <i>Dypsis lutescens</i> c) <i>Phoenix sylvestris</i> d) <i>Ptychosperma macarthurii</i>

104	<i>Ypthima asterope</i>	Poaceae	Bermuda grass/Duba ghasa	<i>Cynodon sp.</i>
105	<i>Mycalesis mineus</i>	Poaceae	Corn grass	<i>Setaria barbata</i>
106	<i>Melanitis phedima</i>	Poaceae	a) Running mountain grass b) Palmgrass/Knotroot	a) <i>Oplismenus compositus</i> b) <i>Setaria palmifolia</i>
107	<i>Ypthima ceylonica</i>	Poaceae	Corn grass	<i>Setaria barbata</i>

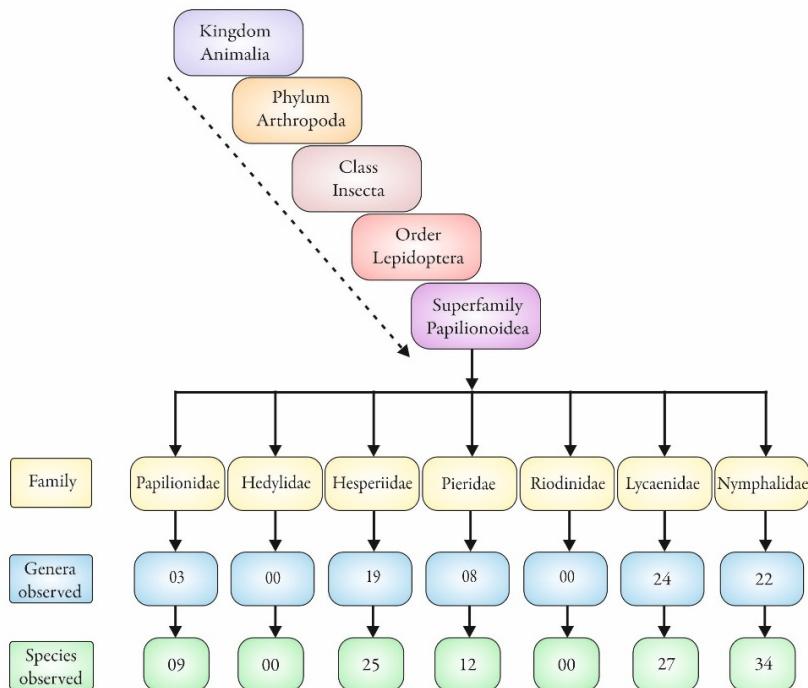


Figure 3. Hierarchy of butterfly indicating the number of species observed in this study
Adapted from Van Niekerken *et al.* (2011)

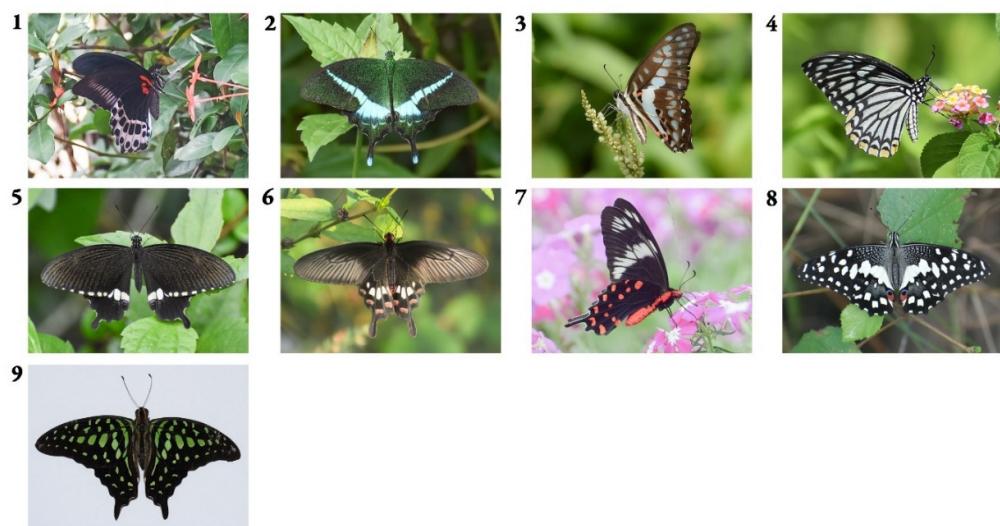


Figure 4. Photographs of butterfly species belonging to the family Papilionidae recorded in this study: (1) *Papilio polymnestor*; (2) *Papilio crino*; (3) *Graphium doson*; (4) *Papilio clytia*; (5) *Papilio polytes*; (6) *Pachliopta aristolochiae*; (7) *Pachliopta hector*; (8) *Papilio demoleus*; (9) *Graphium agamemnon*

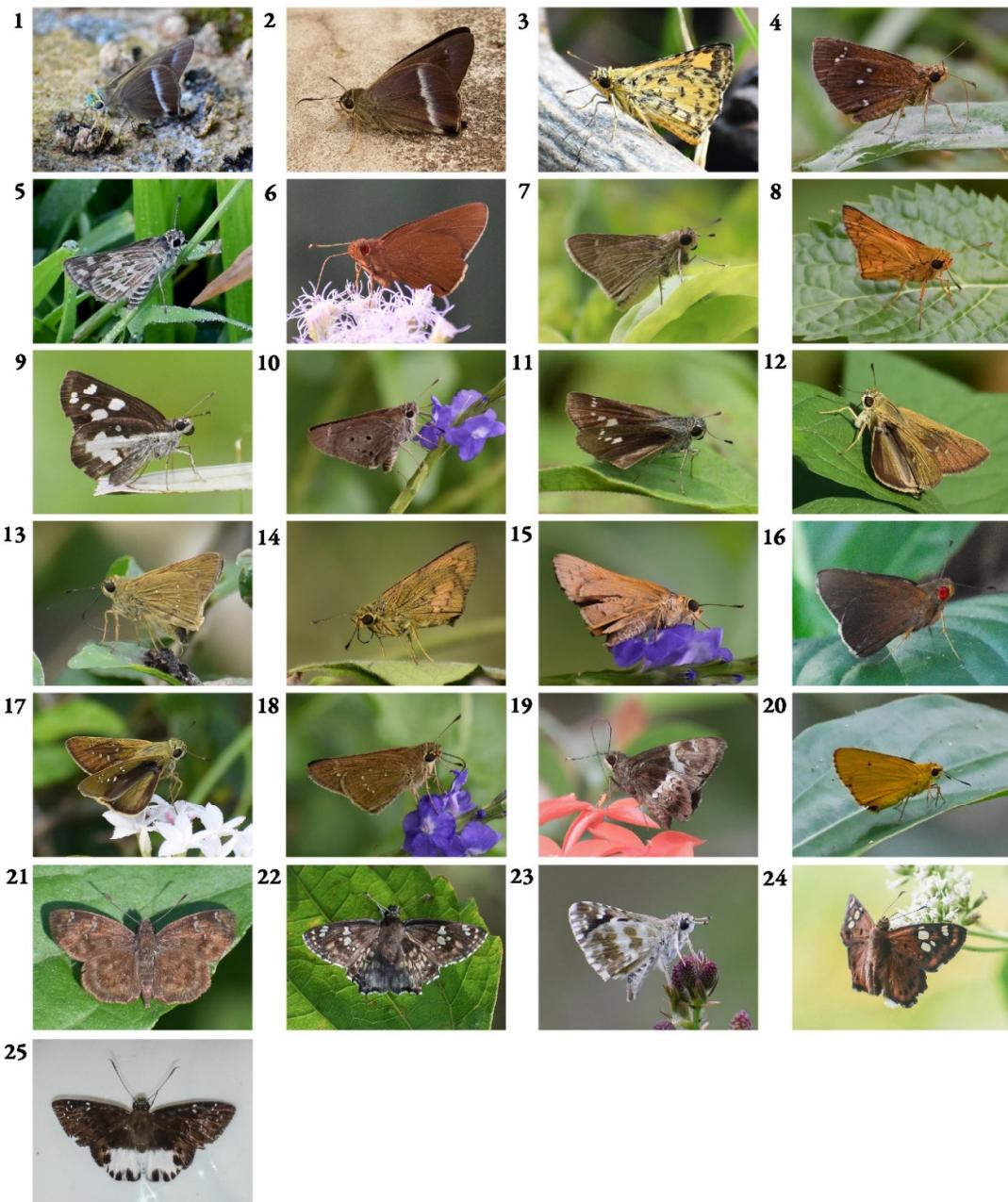


Figure 5. Photographs of butterfly species belonging to the family Hesperiidae recorded in this study: (1) *Hasora chromus*; (2) *Hasora vitta*; (3) *Ampittia dioscorides*; (4) *Iambrix salsala*; (5) *Taractrocera maevius*; (6) *Matapa aria*; (7) *Parnara ganga*; (8) *Telicota aneilla*; (9) *Udaspes folus*; (10) *Suastus gremius*; (11) *Pelopidas subochracea*; (12) *Borbo bevanii*; (13) *Pelopidas agna*; (14) *Telicota colon*; (15) *Cephrenes acalle*; (16) *Matapa purpurascens*; (17) *Borbo cinnara*; (18) *Pelopidas mathias*; (19) *Hyarotis adrastus*; (20) *Cupitha purreea*; (21) *Sarangesa dasahara*; (22) *Caprona ransonnetti*; (23) *Spialia galba*; (24) *Coladenia indranii*; (25) *Tagiades litigiosa*

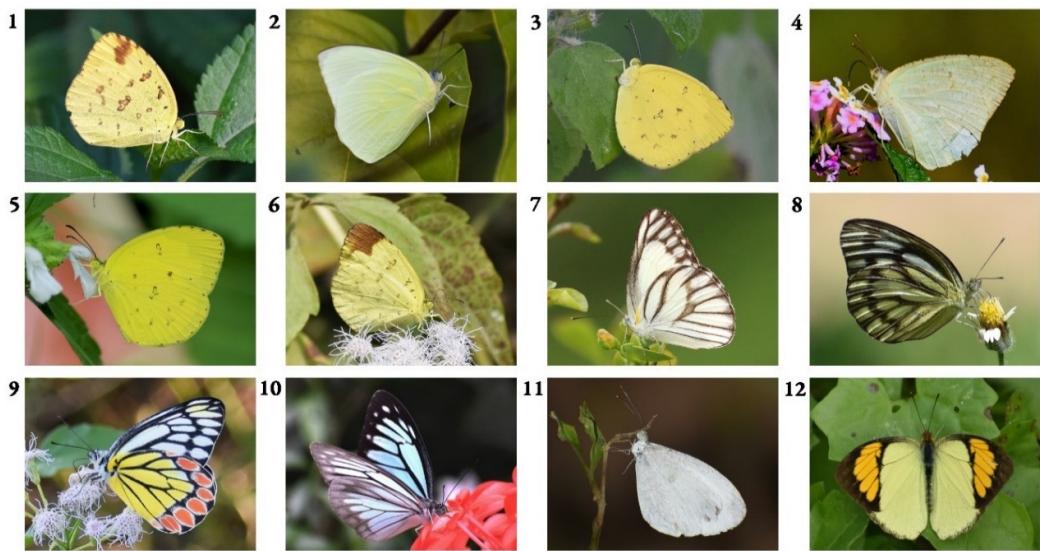


Figure 6. Photographs of butterfly species belonging to the family Pieridae recorded in this study: (1) *Eurema simulatrix*; (2) *Catopsilia pomona*; (3) *Eurema hecabe*; (4) *Catopsilia pyranthe*; (5) *Eurema andersonii*; (6) *Eurema blanda*; (7) *Appias olferna*; (8) *Cepora nerissa*; (9) *Delias eucharis*; (10) *Pareronia hippia*; (11) *Leptosia nina*; (12) *Ixias pyrene*

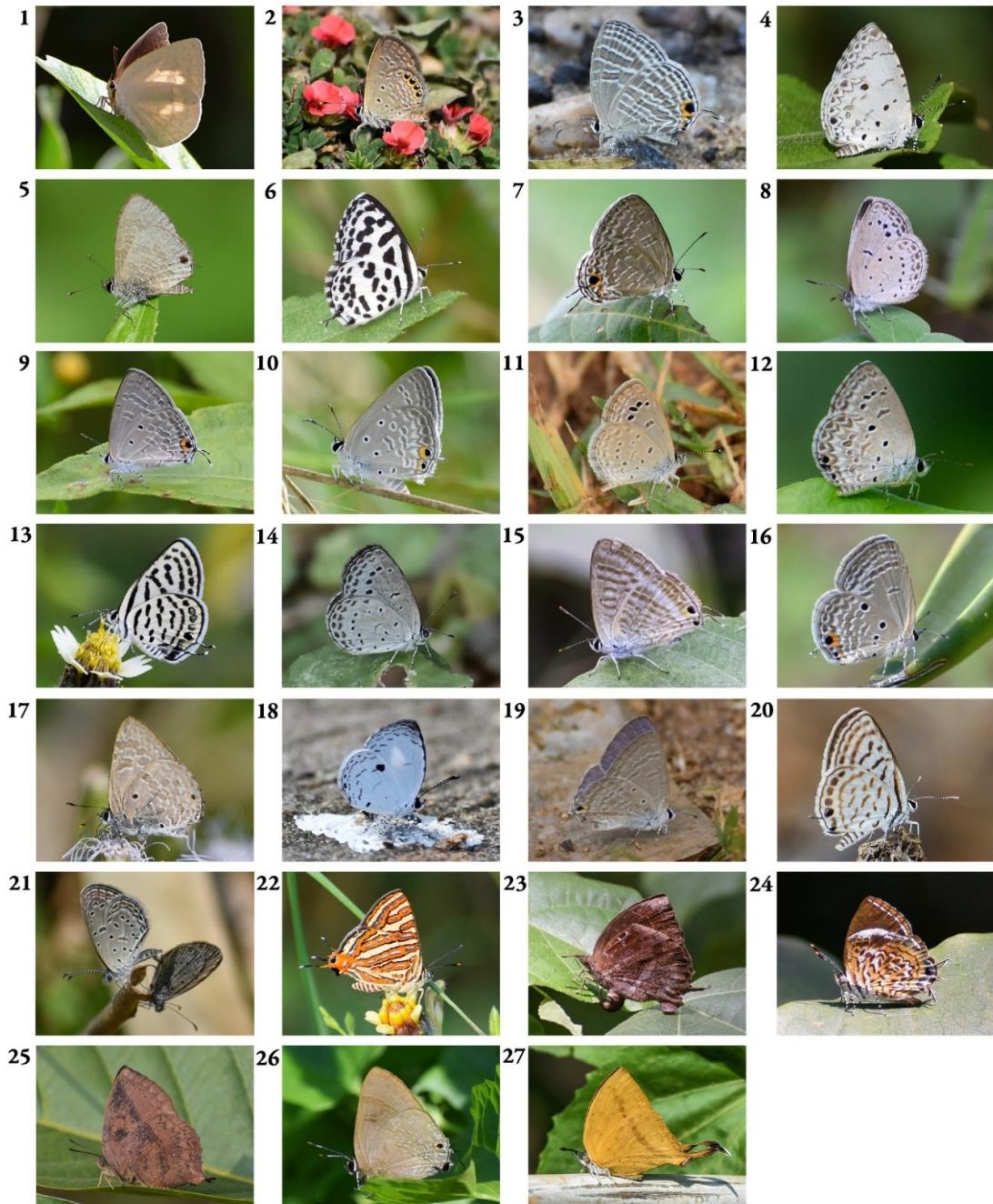


Figure 7. Photographs of butterfly species belonging to the family Lycaenidae recorded in this study: (1) *Curetis thetis*; (2) *Freyeria putli*; (3) *Jamides celeno*; (4) *Acytolepis puspa*; (5) *Prosotas nora*; (6) *Castalius rosimon*; (7) *Jamides bochus*; (8) *Zizeeria karsandra*; (9) *Catochrysops strabo*; (10) *Euchrysops cneus*; (11) *Zizina otis*; (12) *Chilades lajus*; (13) *Tarucus balkanica*; (14) *Pseudozizeeria maha*; (15) *Lampides boeticus*; (16) *Luthrodes pandava*; (17) *Anthene lycaenina*; (18) *Neopithecops zalmora*; (19) *Catochrysops panormus*; (20) *Tarucus nara*; (21) *Zizula hylax*; (22) *Spindasis vulcanus*; (23) *Mahathala ameria*; (24) *Rathinda amor*; (25) *Amblypodia anita*; (26) *Rapala manea*; (27) *Loxura atymnus*



Figure 8. Photographs of butterfly species belonging to the family Nymphalidae recorded in this study: (1) *Ariadne ariadne*; (2) *Ariadne merione*; (3) *Polyura athamas*; (4) *Euploea core*; (5) *Tirumala limniace*; (6) *Parantica aglea*; (7) *Danaus chrysippus*; (8) *Danaus genutia*; (9) *Phalanta phalantha*; (10) *Acraea terpsicore*; (11) *Symphaedra nais*; (12) *Neptis jumbah*; (13) *Moduza procris*; (14) *Euthalia aconthea*; (15) *Pantoporia hordonia*; (16) *Neptis hydas*; (17) *Discophora sondaica*; (18) *Junonia orithya*; (19) *Junonia iphita*; (20) *Hypolimnas misippus*; (21) *Hypolimnas bolina*; (22) *Junonia artites*; (23) *Junonia lemonias*; (24) *Vanessa cardui*; (25) *Junonia almana*; (26) *Lethe europa*; (27) *Mycalesis perseus*; (28) *Melanitis leda*; (29) *Ypthima huebneri*; (30) *Elymnias hypermnestra*; (31) *Ypthima asterope*; (32) *Mycalesis mineus*; (33) *Melanitis phedima*; (34) *Ypthima ceylonica*

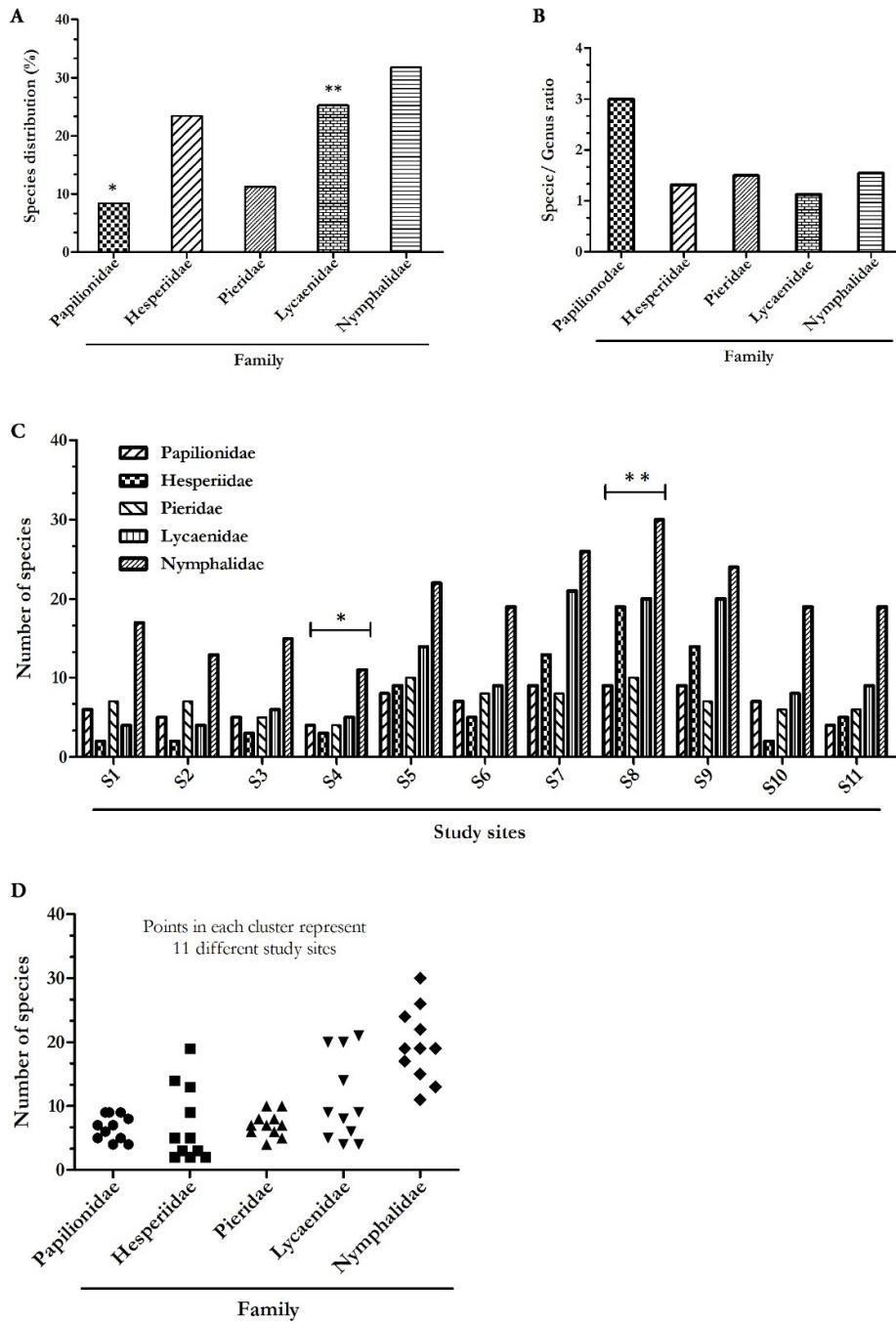


Figure 9. Butterfly species distribution reported in 11 different study sites: (A) Family wise distribution (%) of species; (B) Species to genus ratio (S/G) observed in this study; (C) Number of species distributed in each study site; (D) Cluster graph showing family wise distribution range of species number in 11 different study sites

S, Study sites; *, Lowest species distribution; **, Highest species distribution

Table 4. Species to genus ratio for the recorded species in this study

Sl. no	Family name	No. of Genus (G)	No. of Species (S)	S/G
1	Papilionidae	3	9	3.000
2	Hesperiidae	19	25	1.316
3	Pieridae	8	12	1.500
4	Lycaenidae	24	27	1.125
5	Nymphalidae	22	34	1.545

Table 5. Sørensen's similarity index for butterfly species recorded in the study sites

Study site	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
S1		0.896 *	0.857	0.730	0.687	0.762	0.602	0.565	0.618	0.718	0.734
S2	0.896 *		0.862	0.793	0.617	0.734	0.556	0.521	0.571	0.712	0.703
S3	0.857	0.862		0.852	0.660	0.756	0.595	0.541	0.593	0.684	0.753
S4	0.730	0.793	0.852		0.578	0.693	0.500	0.470 ^	0.535	0.580	0.657
S5	0.687	0.617	0.660	0.578		0.775	0.743	0.689	0.745	0.667	0.623
S6	0.762	0.734	0.756	0.693	0.775		0.688	0.618	0.689	0.689	0.681
S7	0.602	0.556	0.595	0.500	0.743	0.688		0.824	0.848	0.639	0.650
S8	0.565	0.521	0.541	0.470 ^	0.689	0.618	0.824		0.852	0.600	0.611
S9	0.618	0.571	0.593	0.535	0.745	0.689	0.848	0.852		0.621	0.650
S10	0.718	0.712	0.684	0.580	0.667	0.689	0.639	0.600	0.621		0.588
S11	0.734	0.703	0.753	0.657	0.623	0.681	0.650	0.611	0.650	0.588	

Similarity index value marked (*) is highest and marked (^) is the lowest. S1-S11, study sites.

Table 6. Results of one-way ANOVA based on the site wise and family wise distribution of species number

1	Butterfly species among different study sites	Source of variation	SS	df	MS	F stat	P-value	F crit
		Between groups	872.33	10	87.23	2.34	0.026 *	2.05
		Within groups	1641.6	44	37.31			
		Total	2513.9	54				
2	Butterfly species in different families	Source of variation	SS	df	MS	F stat	P-value	F crit
		Between groups	1324.8	4	331.21	13.92	< 0.0001 **	2.55
		Within groups	1189.1	50	23.78			
		Total	2513.9	54				

ANOVA, analysis of variance; SS, sum of squares; df, degrees of freedom; MS, mean squares; F stat, F statistic; P-value, probable value; F crit, critical value of F distribution. F stat values are significant at $p < 0.05$.

Discussion

Out of the total 107 species documented, three species (*Papilio clytia*, *Pachliopta hector* and *Hypolimnas misippus*) are listed in Schedule I, four species (*Euchrysops cneus*, *Lampides boeticus*, *Anthene lycaenina* and *Mahathala amelia*) in Schedule II and two species (*Hasora vitta* and *Hyarotis adrastus*) in Schedule IV of WPA, 1972. The study shows highest S/G ratio for Papilionidae, probably due to their less genetic diversity as compared to other four families. Highest species diversity is observed in the study sites (S8, S7, and S9 respectively), which are mainly dominated by fragmented forest, open scrubs, and croplands having

many host plants to sustain their lifecycle. Least number of butterfly species was recorded in the study sites S2 and S4 comprising urban habitat with continuous anthropogenic activities and less availability of host plants. 17 species are new additions to the existing butterfly data of Bhubaneswar. In this study, Painted Lady (*Vanessa cardui*) is reported only once in the month of April 2019, which could be a result of its well-known long-range migration (Stefanescu *et al.*, 2016). The cluster is more scattered in case of Hesperiidae, Lycaenidae, and Nymphalidae as these families exhibit a greater number of species as compared to Papilionidae and Pieridae. Sørensen's similarity index showed the highest value between the study sites S1 and S2 indicating the highest species overlap, perhaps because they are in close proximity and share a similar type of habitat. Least Sørensen's similarity index has been recorded between the sites S4 and S8 which might be due to the presence of contrasting habitats. One-way ANOVA data suggest there is a significant variation between the butterfly species of different families within the study range. Moreover, a significant variation is observed between the butterfly species among the study sites. The ANOVA results show that the $P < 0.05$ and the value of F statistic is greater than the critical value of F distribution, thereby rejecting the null hypothesis. Butterflies are an integral part of our ecology and play an important role in maintaining the ecological balance. The present documentation provides a reference point and opens new ways of analytical research scopes. Researchers would find better sustainable approaches towards global conservation by understanding the biology of local populations and their dynamics pertaining to rapidly urbanizing geographical ranges. Studying species diversity has become more important in today's world as it serves as a checkpoint for awareness and understanding of interspecific and intraspecific interactions.

Conclusions

The study range supports a rich diversity of butterflies with a wide variety of plants which provide them an ideal breeding habitat. An attempt is made in this study to show the importance of a local area as a model geographical region with diverse habitats, suggesting the importance of local population in long term biodiversity studies and conservation. Therefore, it is imperative to understand the relative dependence of the butterfly species on their habitat. Considering such correlations would help in putting a check on the decreasing number of butterflies due to rapid urbanization and habitat destruction. Further studies on local butterflies of this region, covering various other aspects would undoubtedly contribute a lot towards solving the global issue of conservation of nature and its depleting species.

Authors' Contributions

The manuscript is conceptualized, drafted and supervised by SKS. AS and NP helped equally in data curation and all the authors analysed the data. All the authors contributed equally for the field work while review and editing were done by SKS. All the authors read and approved the final manuscript.

Ethical approval (for researches involving animals or humans)

In this study none of the butterfly species were collected, euthanized or killed by any means. Thus, the images of butterflies represented in the figures are the result of live photography. An entomological net was occasionally used and the butterflies were released unharmed to their natural habitat as soon as they were photographed.

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Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

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