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

Sabindra K. SAMAL*, Aryjit SATAPATHY, Nivedita PATTANAIK

B.J.B. Autonomous College, Department of Zoology, B.J.B. Nagar, Bhubaneswar - 751014, Odisha, India; sabindra.kr.samal@gmail.com (*corresponding author); aryjit89@gmail.com; nivedita.p22@gmail.com
All authors contributed equally to the work

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 (Rusczczak and Silva, 1997; Kehimkar, 2016). Approximately, 18,768 species of butterflies have been recorded worldwide (Van Nieuwerken 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
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/indnews/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/](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, Garden habitat, Urban forest |
| 6       | S6         | Nayapalli              | 20.2977° 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 ($\beta$)

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

$$\beta = \frac{2c}{s1 + s2}$$
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 $\beta$ 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 ($\alpha$) 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 |
|---------|-------------------|-------------|-----------------|-----------|-------------------------|-----------|
| 1       | Sub Family: Papilioninae | Blue mormon | *Papilio polymnestor* | Cramer, 1775 | 120 - 150 |          |
| 2       | Sub Family: Papilioninae | Common banded peacock | *Papilio crino* | Fabricius, 1793 | 80 - 100 |          |
| 3       | Sub Family: Papilioninae | Common jay | *Graphium doson* | (C. & R. Felder, 1864) | 70 - 80 |          |
| 4       | Sub Family: Papilioninae | Common mime | *Papilio clytia* | Linnaeus, 1758 | 90 - 100 | Sch I    |
| 5       | Sub Family: Papilioninae | Common mormon | *Papilio polytes* | Linnaeus, 1758 | 90 - 100 |          |
| 6       | Sub Family: Papilioninae | Common rose | *Pachliopta aristolochiae* | (Fabricius, 1775) | 80 - 110 |          |
| 7       | Sub Family: Hedylinae | Crimson rose | *Pachliopta hector* | Linnaeus, 1758 | 90 - 120 | Sch I    |
| 8       | Sub Family: Hedylinae | Lime | *Papilio demoleus* | Linnaeus, 1758 | 80 - 100 |          |
| 9       | Sub Family: Hedylinae | Tailed jay | *Graphium agamemnon* | (Linnaeus, 1758) | 85 - 100 |          |
| 10      | Sub Family: Coeliadinae | Common banded awl | *Hasora chromus* | (Cramer, [1780]) | 45 - 50 |          |
| 11      | Sub Family: Coeliadinae | Plain banded awl | *Hasora vitta* | (Butler, 1870) | 45 - 55 | Sch IV   |
| 12      | Sub Family: Hesperiinae | Bush hopper | *Ampittia discorides* | (Fabricius, 1793) | 22 - 28 |          |
| 13      | Sub Family: Hesperiinae | Chestnut bob | *Iambris salala* | (Moore, [1866]) | 26 - 30 |          |
| 14      | Sub Family: Hesperiinae | Common grass dart | *Taractrocera maevius* | (Fabricius, 1793) | 22 - 28 |          |
| 15      | Sub Family: Hesperiinae | Common redeye | *Matapa aria* | (Moore, [1866]) | 40 - 55 |          |
| 16      | Sub Family: Hesperiinae | Continental swift | *Parara gansa* | (Evans, 1937) | 30 - 32 |          |
| 17      | Sub Family: Hesperiinae | Dark palm dart | *Telicota ancella* | (Moore, 1878) | 33 - 36 |          |
| 18      | Sub Family: Hesperiinae | Grass demon | *Udaspes folus* | (Cramer, [1775]) | 40 - 48 |          |
| 19      | Sub Family: Hesperiinae | Indian palm bob | *Suastus gremius* | (Fabricius, 1798) | 32 - 45 |          |
| 20      | Sub Family: Hesperiinae | Large branded swift | *Pelopidas subochracea* | (Moore, 1878) | 38 - 42 |          |
| 21      | Sub Family: Hesperiinae | Lesser rice swift | *Borbo bevari* | (Moore, 1878) | 32 - 36 |          |
| 22      | Sub Family: Hesperiinae | Little branded swift | *Pelopidas agra* | (Moore, [1866]) | 30 - 38 |          |
| 23      | Sub Family: Hesperiinae | Pale palm dart | *Telicota colon* | (Fabricius, 1775) | 30 - 36 |          |
| 24      | Sub Family: Hesperiinae | Plain palm dart | *Cephrenes acalle* | (Höpfner, 1874) | 45 |          |
| 25      | Sub Family: Hesperiinae | Purple redeye | *Matapa purpurascens* | Elwes & Edwards, 1897 | 48 - 54 |          |
| 26      | Sub Family: Hesperiinae | Rice swift | *Borbo cinnara* | (Wallace, 1866) | 30 - 36 |          |
| 27      | Sub Family: Pyrginae | Small branded swift | *Pelopidas mathias* | (Fabricius, 1798) | 32 - 38 |          |
| 28      | Sub Family: Pyrginae | Tree flitter | *Hyaratris adrasus* | (Stoll, [1780]) | 38 - 48 |          |
| 29      | Sub Family: Pyrginae | Wax dart | *Cupitha purrea* | (Moore, 1877) | 28 - 33 |          |
| 30      | Sub Family: Pyrginae | Common small flat | *Sarangesa dasahara* | (Fabricius, [1866]) | 26 - 35 |          |
| 31      | Sub Family: Pyrginae | Golden angle | *Caprona ransonnetti* | (R. Felder, 1868) | 35 - 45 |          |
| 32      | Sub Family: Pyrginae | Indian skipper | *Spialia galba* | (Fabricius, 1793) | 22 – 27 |          |
|   |   |   |   |   |
|---|---|---|---|---|
| 33 | Tricolour pied flat | Coladenia indrani | (Moore, [1866]) | 40 – 46 |
| 34 | Water snow flat | Tagiades litigiosa | Moschler, 1878 | 37 – 44 |

### Family Pieridae: The whites and yellows

| Sub Family: | Changeable grass yellow | Eurema simulatrix | (Staudinger, 1891) | 40 - 50 |
|---|---|---|---|---|
| 35 | Common emigrant | Catopsilia pomona | (Fabricius, 1775) | 55 - 80 |
| 36 | Common grass yellow | Eurema hecabe | (Linnaeus, 1758) | 40 - 50 |
| 37 | Mottled emigrant | Catopsilia pyranthe | (Linnaeus, 1758) | 50 - 70 |
| 38 | One-spot grass yellow | Eurema andersonii | (Moore, 1886) | 38 - 45 |
| 39 | Three-spot grass yellow | Eurema blanda | (Boisduval, 1836) | 40 - 45 |
| 40 | Black veined albatross | Appias olferna | Swinhoe, 1890 | 55 - 65 |
| 41 | Common gull | Cepora nerissa | (Fabricius, 1775) | 40 - 65 |
| 42 | Common jezebel | Delias eucharis | (Drury, 1773) | 66 - 83 |
| 43 | Common wanderer | Pareronia hippia | (Fabricius, 1787) | 65 - 80 |
| 44 | Psyche | Leptosia nina | (Fabricius, 1793) | 35 - 50 |
| 45 | Yellow orange-tip | Ixias pyrene | (Linnaeus, 1764) | 50 - 70 |

### Family Riodinidae: The Metal-markers. No butterflies were recorded during this study

### Family Lycaenidae: The gossamer-winged butterflies

| Sub Family: | Sub Family: | Indian sunbeam | Curetis thetis | (Drury, [1773]) | 40 - 48 |
|---|---|---|---|---|---|
| Curetinae | Curetinae | Black-spotted grass jewel | Freyeria putli | (Kollar, [1844]) | 12 - 18 |
| 47 | Curetinae | Common cerulean | Jamides celeno | (Cramer, [1775]) | 27 - 40 |
| 48 | Curetinae | Common hedge blue | Aegytolepis puspa | (Horsfield, [1828]) | 28 - 35 |
| 49 | Curetinae | Common lineblue | Aegytolepis puspa | (Horsfield, [1828]) | 28 - 35 |
| 50 | Curetinae | Common pierrot | Castalius rosinon | (Fabricius, 1775) | 24 - 34 |
| 51 | Curetinae | Dark cerulean | Jamides bochus | (Stoll, [1782]) | 25 - 34 |
| 52 | Curetinae | Dark grass blue | Zizeeria karsandra | (Moore, 1865) | 18 - 24 |
| 53 | Curetinae | Forget-me-not | Catopyrolyca strabo | (Fabricius, 1793) | 25 - 35 |
| 54 | Curetinae | Gram blue | Euchrysops ceneus | (Fabricius, 1798) | 25 - 33 |
| 55 | Curetinae | Lesser grass blue | Zizina otis | (Fabricius, 1787) | 19 - 26 |
| 56 | Curetinae | Lime blue | Chilades laius | (Stoll, [1780]) | 26 - 30 |
| 57 | Curetinae | Little tiger pierrot | Tarucus balkanica | (Freyer, 1844) | 21 - 24 |
| 58 | Curetinae | Pale grass blue | Pseudozizeeria maha | (Kollar, [1844]) | 26 - 30 |
| 59 | Curetinae | Pea blue | Lampides boeticus | (Linnaeus, 1767) | 24 - 36 |
| 60 | Curetinae | Plains cupid | Luthrodes pandava | (Horsfield, 1829) | 25 - 33 |
| 61 | Curetinae | Pointed ciliate blue | Anthene lycaenina | (Felder, 1868) | 24 - 29 |
| 62 | Curetinae | Quaker | Neopithecops zalmora | (Burler, [1870]) | 16 - 30 |
| 63 | Curetinae | Silver forget-me-not | Catopyrolyca strabo | (Fabricius, 1793) | 25 - 35 |
|   | Sub Family | Common Name                  | Scientific Name                        | Author            | Range   |
|---|------------|------------------------------|----------------------------------------|-------------------|---------|
| 66| Sub Family: Theclinae | Striped pierrot | *Tanucus nara* (Kollar, 1848) |       | 16 - 28 |
| 67| Sub Family: Theclinae | Tiny grass blue | *Zizula hylax* (Fabricius, 1775) |       | 16 - 24 |
| 68| Sub Family: Theclinae | Common silverline | *Spindasis vulcanus* (Fabricius, 1775) |       | 26 - 34 |
| 69| Sub Family: Theclinae | Falcate oakblue | *Mahathala ameria* (Hewitson, 1862) |       | 38 - 42 Sch II |
| 70| Sub Family: Theclinae | Monkey puzzle | *Rathinda amor* (Fabricius, 1775) |       | 26 - 28 |
| 71| Sub Family: Theclinae | Purple leaf blue | *Amblypodia anita* (Hewitson, 1862) |       | 45 - 52 |
| 72| Sub Family: Theclinae | Slate flash | *Rapala manca* (Hewitson, 1863) |       | 30 - 33 |
| 73| Sub Family: Theclinae | Yamfly | *Loxura azynius* (Stoll, 1780) |       | 36 - 40 |

### Family Nymphalidae: The brush-footed butterflies

|   | Sub Family: Biblidinae | Common Name                  | Scientific Name                        | Author            | Range   |
|---|------------------------|------------------------------|----------------------------------------|-------------------|---------|
| 74| Sub Family: Biblidinae | Angled castor | *Ariadne ariadne* (Moore, 1884) |       | 45 - 60 |
| 75| Sub Family: Biblidinae | Common castor | *Ariadne merione* (Cramer, [1777]) |       | 45 - 60 |
| 76| Sub Family: Charaxinae | Common nawab | *Polyura athamas* (Drury, 1773) |       | 60 - 75 |
| 77| Sub Family: Danaina | Common crow | *Euploea core* (Cramer, [1780]) |       | 85 - 95 |
| 78| Sub Family: Danaina | Blue tiger | *Tirumala linnaea* (Cramer, [1775]) |       | 90 - 100 |
| 79| Sub Family: Danaina | Glassy tiger | *Parantica aglea* (Stoll, [1782]) |       | 70 - 85 |
| 80| Sub Family: Danaina | Plain tiger | *Danaus chrysippus* (Linnaeus, 1758) |       | 70 - 80 |
| 81| Sub Family: Danaina | Striped tiger | *Danaus genutia* (Cramer, [1779]) |       | 72 - 100 |
| 82| Sub Family: Heliconinae | Common leopard | *Phalanta phalantha* Drury, 1773 |       | 50 - 60 |
| 83| Sub Family: Heliconinae | Tawny coster | *Acrea terpsicore* (Linnaeus, 1758) |       | 50 - 65 |
| 84| Sub Family: Limenitidinae | Baronet | *Symphaedra nais* (Forster, 1771) |       | 60 - 70 |
| 85| Sub Family: Limenitidinae | Chestnut-streaked sailor | *Neptis jumbah* Moore, [1858] |       | 60 - 70 |
| 86| Sub Family: Limenitidinae | Commander | *Moduza proctes* (Cramer, [1777]) |       | 60 - 75 |
| 87| Sub Family: Limenitidinae | Common baron | *Euthalia aconthea* (Cramer, [1777]) |       | 55 - 80 |
| 88| Sub Family: Limenitidinae | Common lascar | *Pantoporia hordonia* (Stoll, [1790]) |       | 45 - 50 |
| 89| Sub Family: Limenitidinae | Common sailor | *Neptis hylas* (Linnaeus, 1758) |       | 50 - 60 |
| 90| Sub Family: Morphinae | Common duffer | *Discophora sondaica* Boisduval, 1836 |       | 80 - 90 Sch I |
| 91| Sub Family: Morphinae | Blue pansy | *Junonia orithya* (Linnaeus, 1758) |       | 45 - 60 |
| 92| Sub Family: Morphinae | Chocolate pansy | *Junonia iphita* (Cramer, [1779]) |       | 55 - 80 |
| 93| Sub Family: Nymphalinae | Danaid eggfly | *Hypolimnas misippus* (Linnaeus, 1764) |       | 70 - 85 |
| 94| Sub Family: Nymphalinae | Great eggfly | *Hypolimnas bolina* (Linnaeus, 1758) |       | 70 - 110 |
| 95| Sub Family: Nymphalinae | Grey pansy | *Junonia atlites* (Linnaeus, 1763) |       | 55 - 60 |
| 96| Sub Family: Nymphalinae | Lemon pansy | *Junonia lemonias* (Linnaeus, 1758) |       | 40 - 60 |
| 97| Sub Family: Nymphalinae | Painted lady | *Vanessa cardui* (Linnaeus, 1758) |       | 55 - 70 |
| 98| Sub Family: Nymphalinae | Peacock pansy | *Junonia almana* (Linnaeus, 1758) |       | 60 - 65 |
| 99| Sub Family: Nymphalinae | Bamboo tree brown | *Lethoe europa* (Fabricius, 1787) |       | 65 - 75 |
| 100| Sub Family: Satyrinae | Common bushbrown | *Mycasis perseus* (Fabricius, 1775) |       | 38 - 55 |
| 101| Sub Family: Satyrinae | Common evening brown | *Melanitis leda* (Linnaeus, 1758) |       | 60 - 80 |
| 102| Sub Family: Satyrinae | Common four-ring | *Ypthima huchneri* Kirby, 1871 |       | 30 - 40 |
103 Common palmfly  
*Elymnias hypermnestra* (Linnaeus, 1763)  60 - 80

104 Common three-ring  
*Ypthima asterope* (Klug, 1832)  30 - 37

105 Dark-branded bushbrown  
*Mycalesis mineus* (Linnaeus, 1858)  40 - 50

106 Dark evening brown  
*Melanitis phedima* (Cramer, [1780])  60 - 70

107 White four-ring  
*Ypthima ceylonica* Hewitson, [1865]  30 - 35

Species marked with (^) reported for the first time from Bhubaneswar. Species marked with (d) 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 | Family | Host plant | Scientific name |
|---------|-------------------|--------|------------|-----------------|
| 1       | *Papilio polyestor* | Rubiaceae | i) Jungle geranium  
ii) Pomelo | i) *Ixora coccinea*  
i) *Citrus maxima* |
| 2       | *Papilio crino* | Rutaceae | a) East Indian satinwood  
b) a) Lemon  
b) Champak/Champa | a) *Citrus limon*  
b) *Chloroxylon swietenia* |
| 3       | *Graphium doson* | Annonaceae | i) Pond apple  
b) Hoom  
c) False Ashoka/Buddha tree  
d) Southern Magnolia/Him champa | i) *Annona glabra*  
b) *Milia tomentosa*  
c) *Polyalthia longifolia*  
d) *Magnolia grandiflora* |
| 4       | *Papilio clytia* | Lauraceae | a) Camphor tree/Camphorwood  
b) Indian bay leaf | a) *Cinnamomum camphora*  
b) *Cinnamomum tamala* |
| 5       | *Papilio polytes* | Rutaceae | a) Bael/Wood apple  
b) Curry leaf tree  
c) Citron/Galgal  
d) Persian lime | a) *Aegle marmelos*  
b) *Murraya koenigii*  
c) *Citrus medica*  
d) *Citrus latifolia* |
| 6       | *Pachliopta aristolochiae* | Aristolochiaceae | a) Indian birthwort  
b) Calico flower/Pipe vine  
c) Chakrani | a) *Aristolochia indica*  
b) *Aristolochia littoralis*  
c) *Thotka siligoua* |
| 7       | *Pachliopta hector* | Aristolochiaceae | a) Indian birthwort  
b) Calico flower/Pipe vine | a) *Aristolochia indica*  
b) *Aristolochia littoralis* |
| 8       | *Papilio demoleus* | i) Fabaceae  
ii) Rhamnaceae  
iii) Rutaceae | i) Babchi/Kushranashini  
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) *Psoralea corylifolia*  
i) *Ziziphus mauritiana*  
iii) *Aegle marmelos*  
ii) *Chloroxylon swietenia*  
c) *Citrus medica*  
d) *Limonia acidissima*  
e) *Murraya koenigii* |
| 9       | *Graphium agamemnon* | i) Annonaceae  
ii) Magnoliaceae | i) Pond apple  
b) Hoom  
c) False Ashoka/Buddha tree  
d) Corky debbar tree  
e) Champak/Champa | i) *Annona glabra*  
b) *Milia tomentosa*  
c) *Polyalthia longifolia*  
d) *Polyalthia suberosa*  
e) *Michelia champaca* |
| 10      | *Hasora chromus* | Fabaceae | Karanja/Indian beech | *Milletta pinnata* |
| 11      | *Hasora vitta* | Fabaceae | a) Arge-leaf pongam  
b) Ardhga/Swardhang | a) *Milletta exensa*  
b) *Endosanara racemose* |
| 12      | *Ampittia dioscorides* | Poaceae | Asian rice | *Oryza sativa* |
| 13      | *Iambrix salala* | Poaceae | a) Indian thorny bamboo  
b) Para grass/Buffalo grass | a) *Bambusa arundinacea*  
b) *Brachia rautica* |
| 14      | *Taractrocera maevius* | Poaceae | Asian rice | *Oryza sativa* |
| 15 | Matapa aria | Poaceae | Indian thorny bamboo | Bambusa arundinacceae |
| 16 | Parnara ganga | Poaceae | Asian rice | Oryza sativa |
| 17 | Telicota aneilla | Poaceae | a) Sugarcanes | a) Saccharum sp. |
| 18 | Udaspes fons | i) Costaceae | i) Crepe ginger | i) Costus speciosus |
| 19 | Suastus gremius | Arccaceae | a) Queen palm | a) Arecastrum romanziiflumum |
| 20 | Pelopidas subochracea | Poaceae | Carpet grass | Axonopus compressus |
| 21 | Borbo bevani | Poaceae | a) Sugarcanes | a) Saccharum sp. |
| 22 | Pelopidas agna | Poaceae | a) Carpet grass | a) Axonopus compressus |
| 23 | Telicota colon | Poaceae | Sugarcane | Saccharum officinarum |
| 24 | Cephrenes acalle | Arccaceae | a) Coconut tree | a) Cocos nucifera |
| 25 | Matapa purpurascens | Asteraceae | Siam weed/Tibra gandha | Chromolaena odorata |
| 26 | Borso cinnara | Poaceae | a) Para草/ Buffalo grass | a) Brachiaria mutica |
| 27 | Pelopidas mathias | Poaceae | a) Sugarcane | a) Saccharum officinarum |
| 28 | Hyarotis adrestus | Arccaceae | Rattan palms | Calamus sp. |
| 29 | Cupitha purrea | Combretaceae | a) Rangoon creeper | a) Combretum indicum |
| 30 | Sarangesa dasahara | Acanthaceae | a) Violet asystasia | a) Asystasia dalzelliana |
| 31 | Caprona ransonneti | Malvaceae | Indian screw tree | Helicteres isora |
| 32 | Spialia galba | i) Malvaceae | i) a) Common wireweed | i) a) Sida acuta |
| 33 | Coladenia indrani | ii) Malvaceae | ii) b) Chocolateweed | ii) Waltheria indica |
| 34 | Tagiades litigiosa | i) Dioscoreaceae | i) a) Bidi leaf tree | i) Buthinia racemosa |
| 35 | Eurema simulatrix | Fabaceae | Golden shower/Indian laburnum | Cassia fistula |
| 36 | Catopsilia pomona | i) Apocynaceae | i) Conkerberry/Bush plum | i) Carissa spinarum |
| 37 | Eurema hecabe | Fabaceae | a) Rain tree/ Monkey pod | a) Allistia saman |
| 38 | Catopsilia pyranthe | i) Apocynaceae | i) Conkerberry/Bush plum | i) Carissa spinarum |
| 39 | Eurema andersonii | Rhamnaceae | Toothed-leaf red creeper | Ventilago denticulata |
| 40 | Eurema blandia | Fabaceae | Purple orchid tree | Bauhinia purpurea |
| 41 | Appias olferna | Capparaceae | Fringed spider flower | Cleome rutidosperma |
| No. | Species              | Family            | Common Names                                                                 |
|-----|----------------------|-------------------|------------------------------------------------------------------------------|
| 42  | Cepora nerissa       | Capparaceae       | a) Caper shrubs/Caperbushes  
b) Ceylon caper                        | a) Capparis sp.                                      |
|     |                      |                   |                                                                              | b) Capparis zeylanica                           |
| 43  | Delias eucharis      | Lorantheaee/iii  | i) Honey suckle mistletoe  
ii) Neem                             | i) Dendrophthoe falkata                         |
|     |                      | Melliaceae        |                                                                              | ii) Azadirachta indica                           |
| 44  | Pateronia hippia     | Capparaceae       | a) Caper shrubs/Caperbushes  
b) Ceylon caper                        | a) Capparis sp.                                      |
|     |                      |                   |                                                                              | b) Capparis zeylanica                           |
| 45  | Leptosia nina        | Capparaceae       | a) Fringed spiderflower/Purple clemone  
b) Asian spiderflower/Tick weed  
c) Caper shrubs/Caper bushes | a) Cleome rutidosperma                         |
|     |                      |                   |                                                                              | b) Cleome viscosa                                 |
|     |                      |                   |                                                                              | c) Capparis sp.                                      |
| 46  | Ixias pyrene         | Capparaceae       | a) Spreading caper  
b) Wild caper bush                                  | a) Capparis divaricata                         |
|     |                      |                   |                                                                              | b) Capparis septia                                 |
| 47  | Curetis thetis       | Fabaceae          | a) Jequirity bean/Rosary pea  
b) Flame-of-the-forest/Palash  
c) Karanja/Indian beech       | a) Abrus precatorius                         |
|     |                      |                   |                                                                              | b) Butea monosperma                                 |
|     |                      |                   |                                                                              | d) Millettia pinnata                             |
| 48  | Freyeria putli       | i) Asteraceae     | i) Tridax daisy  
ii) Boraginaceae  
iii) Fabaceae | i) Tridax procumbens                         |
|     |                      |                   |                                                                              | ii) Heliotropium indicum                          |
|     |                      |                   |                                                                              | iii) Indigofera linfolia                          |
| 49  | Jamides celeno       | i) Fabaceae       | i) a) Ashoka tree  
b) Mung bean/Green gram  
ii) Green/True cardamom        | i) a) Saraca asoca                         |
|     |                      |                   |                                                                              | b) Vigna radiata                                 |
|     |                      |                   |                                                                              | ii) Eletraria cardamomum                        |
| 50  | Acyroptis puspa       | ii) Phyllanthaceae| i) Mexican lilac  
ii) Spinosus kino tree  
iii) Kurpa               | i) Gliricidia sepium                         |
|     |                      | iii) Sapindaceae  |                                                                              | ii) Bridelia retusa                                 |
|     |                      |                   |                                                                              | iii) Leptisanthus tetraphylla                      |
| 51  | Prosotas nora        | i) Euphorbiaceae  | i) Kamala/Kumkum tree  
ii) Twisted acacia  
iii) Indian alophylos/Tit berry | i) Mallotus philippensis                        |
|     |                      | ii) Mimosaceae    |                                                                              | ii) Acacia torta                                 |
|     |                      | iii) Sapindaceae  |                                                                              | iii) Allophylus cobbe                             |
| 52  | Castulus rosinmon    | Rhamnaceae        | a) Jujube/Red date  
b) Jhar beri                       | a) Ziziphus ziziba                               |
|     |                      |                   |                                                                              | b) Ziziphus nummularia                            |
| 53  | Jamides bochus       | Fabaceae          | a) Ashoka tree  
b) Burma ironwood                   | a) Saraca asoca                                 |
|     |                      |                   |                                                                              | b) Xyla xylocarpa                                 |
| 54  | Zizeeria karsandra   | i) Amaranthaceae  | i) Spiny amaranthus  
ii) Lotus sweetjuice  
iii) Common knotweed  
iv) Bindii              | i) Amaranthus spinosus                        |
|     |                      | ii) Molluginaceae |                                                                              | ii) Glinus lotoide                                |
|     |                      | iii) Polygonaceae |                                                                              | iii) Polygonum plebeium                           |
|     |                      | iv) Zygophyllaceae|                                                                              | iv) Tribulus terrestris                           |
| 55  | Catohrysops strabo   | i) Fabaceae       | i) a) Asian tick trefoil  
b) Karanja/Indian beech  
c) Common tephrosia  
ii) Indian Allophylus/Tit berry | i) a) Desmodium heterocarpum                        |
|     |                      | ii) Sapindaceae   |                                                                              | b) Millettia pinnata                             |
|     |                      |                   |                                                                              | c) Tephrosia purpurea                             |
|     |                      |                   |                                                                              | ii) Allophylus cobbe                             |
| 56  | Euchrysops cneaus     | Fabaceae          | a) Flame-of-the-forest/Palash  
b) Sword bean                        | a) Butea monosperma                             |
|     |                      |                   |                                                                              | b) Canavalia gladiata                             |
| 57  | Zizina otis           | Fabaceae          | a) Asian tick trefoil  
b) Chinchani/Kansevari  
c) Three-leaf indigo          | a) Desmodium heterophyllum                        |
|     |                      |                   |                                                                              | b) Scabiana bipinosa                               |
|     |                      |                   |                                                                              | c) Indigofera trifoliata                           |
| 58  | Chilades lajus        | Rutaceae          | a) Sweet lemon  
b) Lemon  
c) Pomelo  
ii) Kamini/Orange jasmine | a) Citrus limetta                          |
|     |                      |                   |                                                                              | b) Citrus limon                                    |
|     |                      |                   |                                                                              | c) Citrus maxima                                    |
|     |                      |                   |                                                                              | d) Murraya paniculata                             |
| 59  | Tarucus balkanica    | Rhamnaceae        | a) Jujuba/Red date  
b) Jhar beri                       | a) Ziziphus jujuba                                |
|     |                      |                   |                                                                              | b) Ziziphus nummularia                            |
| 60  | Pseudozizereria maha  | Oxalidaceae       | Creeping woodsorrel                        | Buta monosperma                                    |
|     |                      |                   |                                                                              | b) Pisum sativum                                         |
| 62 | Luthrodes pandava | 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) Cycas circinalis  
b) Cycas pectinata  
c) Cycas revoluta  
ii) a) Bauhinia vahlii  
b) Bauhinia variegata  
c) Canavalia gladiata  
d) Saraca asoca |
| 63 | Anthene lycaenina | i) Anacardiaceae  
ii) Euphorbiaceae  
iii) Fabaceae | i) Chironji/Charoli  
ii) Putranjiva  
iii) a) Rosewood/Indian palisandre  
b) Shikakai | i) Buchanania lancea  
ii) Drypetes roxburghii  
iii) a) Dalbergia latifolia  
b) Acacia concinna |
| 64 | Neopithecops zalmora | Rutaceae  
Orange berry/Gin berry | Glycosmis pentaphylla |
| 65 | Catohrysops panormus | Fabaceae  
Large leaf fleminga | Flemingia macrophylla |
| 66 | Tarucus nara | Rhamnaceae | a) Jujuba/Red date  
b) Jhar beri | a) Ziziphus jujuba  
b) Ziziphus nummularia |
| 67 | Zizula hylax | i) Acanthaceae  
ii) Verbenaceae | a) Temple plant/Marsh barbel  
b) Desert petunia  
ii) Raimuniya | a) Hygrophila auriculata  
b) Ruellia simplex  
c) Lantana camara |
| 68 | Spindasis vulcanus | i) Apocynaceae  
ii) Dioscoreaceae  
iii) Fabaceae  
v) Rhamnaceae | a) Bengal currant/Karanda  
b) Bana alu/Pita alu  
iii) Golden shower/Indian laburnum  
v) Jujube/Red date | a) Carissa carandas  
b) Dioscorea wallichii  
c) Cassia fistula  
v) Ziziphus zuzuba |
| 69 | Mahathala anergia | Euphorbiaceae  
Climbing liana | Mallotus repandus |
| 70 | Rathinda amor | i) Anacardiaceae  
ii) Lecythidaceae  
iii) Rubiaceae  
iv) Sapindaceae | i) Mango  
ii) Wild guava  
iii) Jungle geranium  
v) Litchi | i) Mangifera indica  
ii) Carica papaya  
ii) Ixora coccinea  
v) Litchi chinensis |
| 71 | Amblypodia anita | Olacaceae  
South Asian olax | Olax imbricata |
| 72 | Rapala manea | i) Combretaceae  
ii) Lamiaceae  
iii) Verbenaceae | i) Rangoon creeper  
ii) Bhat/Hill glory flower  
iii) Raimuniya | i) Combretum indicum  
ii) Clerodendrum infortunatum  
iii) Lantana camara |
| 73 | Loxura atymnus | i) Dioscoreaceae  
ii) Smilacaceae | i) Five-leaf yam  
b) Kumaria | i) Dioscorea pentaphylla  
b) Smilax zeylanica |
| 74 | Ariadne ariadne | Euphorbiaceae | a) Castor bean/Castor  
b) Indian stinging nettle | a) Ricinus communis  
b) Tragia involucrata |
| 75 | Ariadne merione | Euphorbiaceae | a) Castor bean/Castor  
b) Indian stinging nettle | a) Ricinus communis  
b) Tragia involucrata |
| 76 | Polyura athamas | Fabaceae | a) Twisted acacia  
b) Royal poinciana/Gulmohar  
c) Woman's tongue tree | a) Acacia torta  
b) Delonix regia  
c) Albizia lebbeck |
| 77 | Euploea core | 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) Adenium obesum  
b) Carissa carandas  
c) Nerium oleander  
ii) a) Ficus arnottiana  
b) Ficus benghalensis  
c) Ficus racemosa  
iii) Mimusops elengi |
| 78 | Tirumala limniace | Apocynaceae | a) Apple of sodom/Arak  
b) Tropical milkweed/Bloodflower  
c) Bread flower | a) Calotropis procera  
b) Asclepias curassavica  
c) Vallaris solanacea |
| 79 | Parantica aglea | Apocynaceae | a) Crown flower  
b) Bulbous ceropegia | a) Calotropis gigantea  
b) Ceropegia bulbosa |
|   | Common Name | Family | Scientific Name | Genus | Species | Lat Name |
|---|-------------|--------|-----------------|-------|---------|---------|
| 80 | Danaus chrysippus | Apocynaceae | a) Crown flower b) Tropical milkweed/Bloodflower c) Balloon plant | Acalypha | gigantea | a) Calotropis gigantea b) Asclepias curassavica c) Gomphocarpus physocarpus |
| 81 | Danaus genutia | Apocynaceae | Tropical milkweed/Bloodflower | Asclepias | curassavica | A) Flaccourtia indica b) Flaccourtia jangomas c) Flaccourtia montana |
| 82 | Phalanta phalantha | Salicaceae | a) Governor's plum/Batoko plum b) Indian coffee plum c) Mountain sweet thorn | Gomphocarpus | physocarpus | A) Passiflora foetida b) Turnera subulata ii) Hybanthus enneaspermus |
| 83 | Acras terpsicore | a) Passifloraceae ii) Violaceae | i) a) Stinking passionflower b) White buttercup ii) Spade flower | Gomphocarpus | physocarpus | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 84 | Symphaedra nais | a) Ebenaceae ii) Malvaceae | i) a) Governor's plum/Batoko plum b) Indian coffee plum c) Mountain sweet thorn | Gomphocarpus | physocarpus | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 85 | Danaus genutia | Apocynaceae | Tropical milkweed/Bloodflower | Asclepias | curassavica | A) Flaccourtia indica b) Flaccourtia jangomas c) Flaccourtia montana |
| 86 | Moduza prociris | i) Capparaceae ii) Rubiaceae | i) a) Ashanti blood/Red flag bush b) Dholi tree/Mussaenda c) Buffleflower-tree/Kadamb | Flacourtia | indica | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 87 | Euthalia aconthea | Anacardiaceae | i) a) Cashew b) Mango | Flacourtia | jangomas | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 88 | Pantophobia hordonia | Fabaceae | a) Golden shower/Indian laburnum b) Indian rosewood | Flacourtia | montana | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 89 | Neptis jumbah | Fabaceae | a) Golden shower/Indian laburnum b) Indian rosewood | Flacourtia | indica | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 90 | Discophora sondaica | Poaceae | a) Indian oak b) Indian willow | Flacourtia | jangomas | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 91 | Junonia orithya | i) Acanthaceae ii) Moraceae | i) a) Philippine violet b) Water willow c) Roundleaf kariyat | Flacourtia | indica | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 92 | Hypolimnas misippus | i) Acanthaceae ii) Malvaceae iii) Salicaceae | i) a) Cashew b) Mango c) Indian willow | Flacourtia | indica | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 93 | Hypolimnas bolina | Urticaceae | a) Indian oak b) Indian willow | Flacourtia | indica | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 94 | Hypolimnas bolina | Urticaceae | a) Indian oak b) Indian willow | Flacourtia | indica | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 95 | Junonia almana | Acanthaceae | a) Philippine violet b) Marsh barbel/Kokilaksha | Flacourtia | indica | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 96 | Junonia almana | Acanthaceae | a) Philippine violet b) Water willow c) Roundleaf kariyat | Flacourtia | indica | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 97 | Vanessa cardui | i) Acanthaceae ii) Fabaceae iii) Papaveraceae | i) a) Coatbuttons/Tridax daisy b) Two-leaf zornia c) Mexican prickly poppy | Flacourtia | indica | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 98 | Junonia almana | Acanthaceae | a) Philippine violet b) Marsh barbel/Kokilaksha | Flacourtia | indica | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 99 | Lethe europa | Poaceae | a) Bamboo b) Running mountain grass | Flacourtia | indica | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 100 | Mycalesis perseus | Poaceae | a) Running mountain grass b) Barnyard grass/Cockspur grass | Eleusine | indica | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 101 | Melanitis leda | Poaceae | a) Maize/Corn b) Indian thorny bamboo c) Indian goosegrass | Eleusine | indica | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 102 | Ypthima huebneri | Poaceae | a) Areca palm b) Golden cane palm c) Silver date palm/Indian date d) Macarthur palm | Eleusine | indica | a) Passiflora foetida ii) Hybanthus enneaspermus |
| 103 | Elymnias hypermnestra | Arecales | a) Areca palm b) Golden cane palm c) Silver date palm/Indian date d) Macarthur palm | Eleusine | indica | a) Passiflora foetida ii) Hybanthus enneaspermus |
| No. | Species                      | Family      | Genus observed | Species observed | Kingdom Animalia | Phylum Arthropoda |
|-----|------------------------------|-------------|----------------|------------------|-------------------|------------------|
| 104 | *Ypthima asterope*          | Poaceae     |                |                  |                   |                  |
| 105 | *Mycalesis mineus*          | Poaceae     | Bermuda grass/Duba ghasa |                |                   |                  |
| 106 | *Melanitis phedima*         | Poaceae     | a) Running mountain grass |                |                   |                  |
|     |                              |             | b) Palmgrass/Knotroot |                |                   |                  |
| 107 | *Ypthima ceylonica*         | Poaceae     | Corn grass     | Setaria barbata  |                   |                  |

**Figure 3.** Hierarchy of butterfly indicating the number of species observed in this study
Adapted from Van Nieukerken 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) Lambrux salsala; (5) Taractrocera maevius; (6) Matapa aria; (7) Parmara ganga; (8) Telicota aneilla; (9) Udaspes folus; (10) Suastus gremius; (11) Pelopidas subochracea; (12) Borbo bevanti; (13) Pelopidas agna; (14) Telicota colon; (15) Cephenes acalle; (16) Matapa purpurascens; (17) Borbo cinnara; (18) Pelopidas mathias; (19) Hyarotis adrastus; (20) Cupitha purrea; (21) Sarangesa dasahara; (22) Caprona ransonnetti; (23) Spialia galba; (24) Coladenia tindrani; (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 ncalla*; (9) *Delias eucharis*; (10) *Parchonia hippia*; (11) *Leptosia nina*; (12) *Ixia 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) Acyroplepis puspa; (5) Prosotas nora; (6) Castalus rosimon; (7) Jamides bochus; (8) Zizeeria karsandra; (9) Catochrysops strabo; (10) Euchrysops cneus; (11) Zizina otis; (12) Chilades laius; (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 aymnas
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) Actaea terpsicore; (11) Symphaedra nais; (12) Neptis jumbah; (13) Moduza procris; (14) Euthalia aconthea; (15) Pantoporia hordonia; (16) Neptis hylas; (17) Discophora sondaica; (18) Junonia orithya; (19) Junonia iphita; (20) Hypolimnas misippus; (21) Hypolimnas bolina; (22) Junonia ataltes; (23) Junonia leonidas; (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 | 0.535 | 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

| 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 | 47.54 |       |         |        |

| 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 | 47.54 |        |         |        |

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 cnejus, Lampides boeticus, Anthene lycænina and Mahathala ameria) in Schedule II and two species (Hasora vitta and Hyarotis adrasus) 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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