



# Annotated checklist of butterflies of Ankleshwar—an industrial town in Gujarat, India

Azaz Sidat<sup>1</sup>, Urjit Bhatt<sup>2</sup>

**1** The Maharaja Sayajirao University of Baroda, Sayajigunj, Vadodara 390002, Gujarat, India. **2** Wildlife Institute of India, Chandrabani, Dehradun 248001, Uttarakhand, India.

**Corresponding author:** Urjit Bhatt, [urjit@wii.gov.in](mailto:urjit@wii.gov.in)

---

## Abstract

Urbanization threatens the diversity of butterflies due to habitat fragmentation with environmental degradation. Butterflies, as potent pollinators and ecological indicators, are important in conservation planning and environmental monitoring. This study provides a comprehensive insight into the species diversity of butterflies in Ankleshwar, an industrial town in Gujarat, India, and has potential use in urban planning and conservation. A total of 63 species belonging to five families were photo-documented and identified. The richest family was Nymphalidae, followed by Pieridae, Lycaenidae, Hesperidae, and Papilionidae. *Junonia* Hübner, [1819] and *Colotis* Hübner, [1819] were the dominant genera with five species each. Six species have the IUCN status of Least Concern but 57 species are Not Evaluated. Seven species are afforded protection under the Wildlife Protection Act, 1972. This study highlights the need to conserve rare and threatened butterfly species.

## Keywords

Conservation planning, ecological indicator, IUCN status, Lepidoptera, urban landscape, Wildlife Protection Act.

---

**Academic editor:** Ivan N. Bolotov | Received 1 May 2020 | Accepted 30 July 2020 | Published 10 August 2020

**Citation:** Sidat A, Bhatt U (2020) Annotated checklist of butterflies of Ankleshwar—an industrial town in Gujarat, India. *Check List* 16 (4): 997–1015. <https://doi.org/10.15560/16.4.997>

---

## Introduction

Biodiversity knowledge is important for assessing the overall health of ecosystems, as well as for the development of proper conservation plans, especially in ecologically sensitive groups such as butterflies (Lepidoptera, Rhopalocera) (Chowdhury and Soren 2011). Butterflies are pivotal in the stability of food webs as herbivores (Rusman et al. 2016), pollinators (Mukherjee et al. 2015), hosts of parasitoids (van Nouhuys and Hanski 2002), and prey of predators (Rusman et al. 2016). Numerous species act as biological indicators of environmental health and ecological changes (Thomas 2005; Poshal and Sodhi 2006; Koh 2007) due to their sensitivity to habitat

fragmentation and climate change (Kunte 2000).

Urban expansion is threatening global biodiversity by destroying natural and seminatural habitats and increasing the levels of anthropogenic disturbances, such as habitat degradation that decreases plant species, reduces water quality, and increases air and soil pollution (McKinney 2002; Garg et al. 2009; Singh et al. 2009; Lintott et al. 2014). Urbanization in cities has rapidly created many fragmented land patches, while very few places have been retained or converted to green areas for the conservation of the local flora and fauna. The increase in the human population and advances in

technology have directly affected the ecosystems, making many lepidopterans unable to adapt to these changes (Brattstrom et al. 2008).

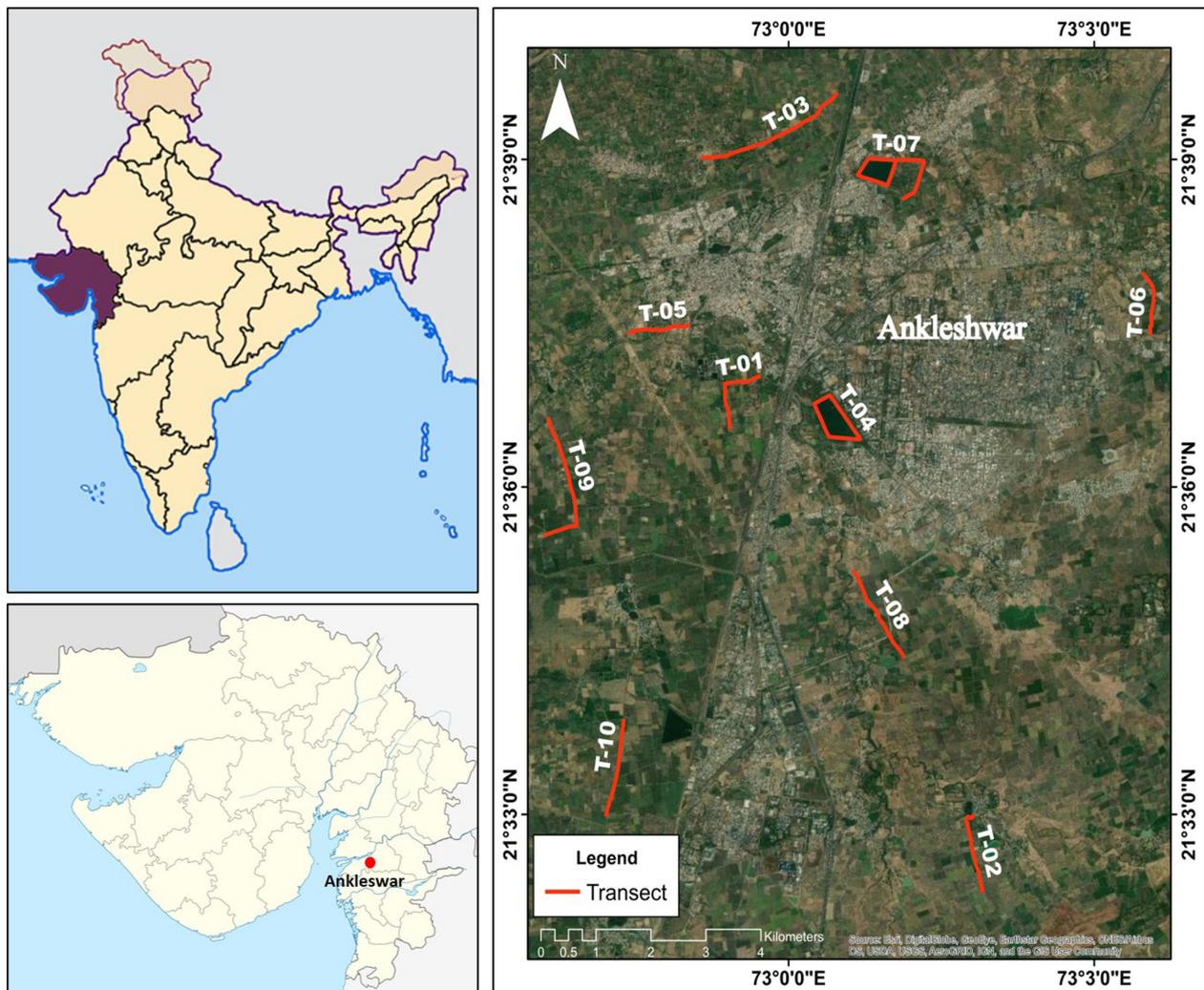
Butterflies, being poikilotherms, respond to such environmental changes with sharp declines in their diversity. Butterflies are an important part of biodiversity because they have considerable resonance with both the general public and decision-makers (Kuhn et al. 2008). While urban green areas may reduce the impact of urbanization on biodiversity, it is often over-managed and ends up in small, fragmented patches which may be isolated (Kuhn et al. 2008). Effective management strategies for urban landscapes require proper understanding of the ecology and habitat requirements of all relevant taxa. Yet, little is known of how butterflies utilize urban landscapes, despite their common occurrence.

While there are recent studies of butterflies in other urban and semi-urban areas of India (Sarma et al. 2012; Shobana et al. 2012; Tiple 2012; Kaneria et al. 2013; Kumar 2013; Arya et al. 2014; Thangapandian et al. 2014; Mukherjee et al. 2016; Bhatt and Nagar 2017), including in gardens and campuses of universities, there has possibly been no work done in and around an

industrial town. Our study examines the diversity and species richness of butterflies in the town of Ankleshwar and discusses the conservation needs of rare and threatened butterfly species.

## Methods

**Study site.** Our study was carried out in Ankleshwar, an industrial town in the Bharuch district of the state of Gujarat, India (Fig. 1). The town is known for the Gujarat Industrial Development Corporation (GIDC), which was established under the Gujarat Industrial Development Act of 1962 with a goal of accelerating industrialization in the state. Ankleshwar has over 1,500 chemical plants, which produce pesticides, other chemicals, pharmaceuticals, textiles, and paints. The industrial town is mainly surrounded by rural areas and also by industrial suburban areas. Agricultural fields and barren lands cover the outskirts of the rural and suburban areas, which are mostly dominated by species of *Acacia* Martius, *Ziziphus* Mill., and *Prosopis* L. The crops in this area are mostly wheat, bajra, sugarcane, tovar, and cotton. The study site is situated in a semi-arid zone with an average rainfall of



**Figure 1.** A satellite overview map of the study site (Ankleshwar, an industrial town of India) and walked transects ( $N = 10$ ). (Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community).

945 mm and a temperature range of 12.4–44.6 °C (IMD 2017, 2018).

**Data collection.** The survey was conducted from January 2018 to December 2019 during all seasons (i.e., winter [December–February], summer [March–May], monsoon [June–September], and post-monsoon [October–November]), except during heavy rains and high winds. Depending on the seasonal variation, field observations were made in the early mornings from sunrise to 11:00 am and in the evenings from 4:00 pm to sunset. The Pollard walk method was used for recording the butterflies (Pollard 1977, 1991).

Ten belt transects were evenly distributed throughout the study site. Each transect had a fixed path, length, and width (Table 1). All transects were visited once in a month, and butterfly species were recorded from both sides of the path for a distance of 5 m to ensure a consistent observation area. Five transects (T-01, T-02, T-03, T-08, and T-09) were selected on agricultural field roads or barren/discarded lands with shrubs, grasses, and weeds, while the remaining five (T-04, T-05, T-06, T-07, and T-10) were laid down in the periphery of residential and industrial areas (Table 1). Transects were walked at a steady pace, and during the walk, short stops were made for proper documentation and identification. Butterfly specimens were recorded by visual observations, with the aid of Olympus 8–16×40 DPS binoculars (Olympus Imaging India Pvt. Ltd., Mumbai, India) and Canon EOS 550D and Canon EOS 60D cameras equipped with a Canon 18–135 mm lens (Canon Inc., Tokyo, Japan).

Butterflies were observed, photographed, and identified with the help of literature (Evans 1932; Wynter-Blyth 1957; Gay et al. 1992; Lewington 1999; Kunte 2000; Parasharya and Jani 2007; Singh 2011; Kehimkar 2016). Species richness was calculated as the total number of species in a group in an area. Butterfly species were categorized by IUCN Red List categories (IUCN 2020) and their status under the Wildlife Protection Act, 1972 (Anonymous 2006).

## Results

**Species richness.** Sixty-three species of butterflies belonging to five families were recorded (Fig. 2; Table 2).

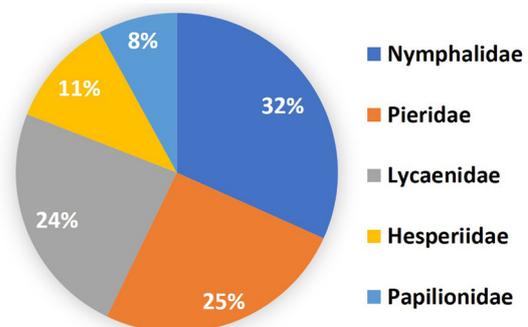
Nymphalidae was the richest family, comprising 20 species (31.7%), followed by Pieridae (16 species, 25.4%), Lycaenidae (15 species, 23.8%), Hesperidae (seven species, 11.1%), and Papilionidae (five species, 7.9%). Most of the genera were represented by single species (Fig. 3). *Junonia* Hübner, [1819] (Nymphalidae) and *Colotis* Hübner, [1819] (Pieridae) were the most species-rich genera, with each represented by five species.

**Threat status.** Of the species recorded, six have been given the IUCN status of Least Concern: *Pachliopta aristolochiae* (Fabricius, 1775), *Danaus chrysippus* (Linnaeus, 1758), *Euploea core* (Cramer, 1780), *Junonia almana* (Linnaeus, 1758), *Zizeeria karsandra* (Moore, 1865), and *Lampides boeticus* (Linnaeus, 1767) (IUCN 2020). The remaining 57 species are unranked as Not Evaluated. Seven species have a protected status under the Indian Wildlife Protection Act (WPA), 1972, including *Hypolimnas misippus* (Linnaeus, 1764) and *Castalius rosimon* (Fabricius, 1775) under Schedule I of part IV of the Act, *Parantica aglea* (Stoll, 1782), *Cepora nerissa* (Fabricius, 1775), *Euchrysops cnejus* (Fabricius, 1798), and *Lampides boeticus* under Schedule II of part II, and *Euploea core* under Schedule IV.

### Annotated list.

#### Family Papilionidae

Commonly known as Swallowtails; species with tailed hindwings and caterpillars with forked organ (osmeterium) at the base of the back of the head.



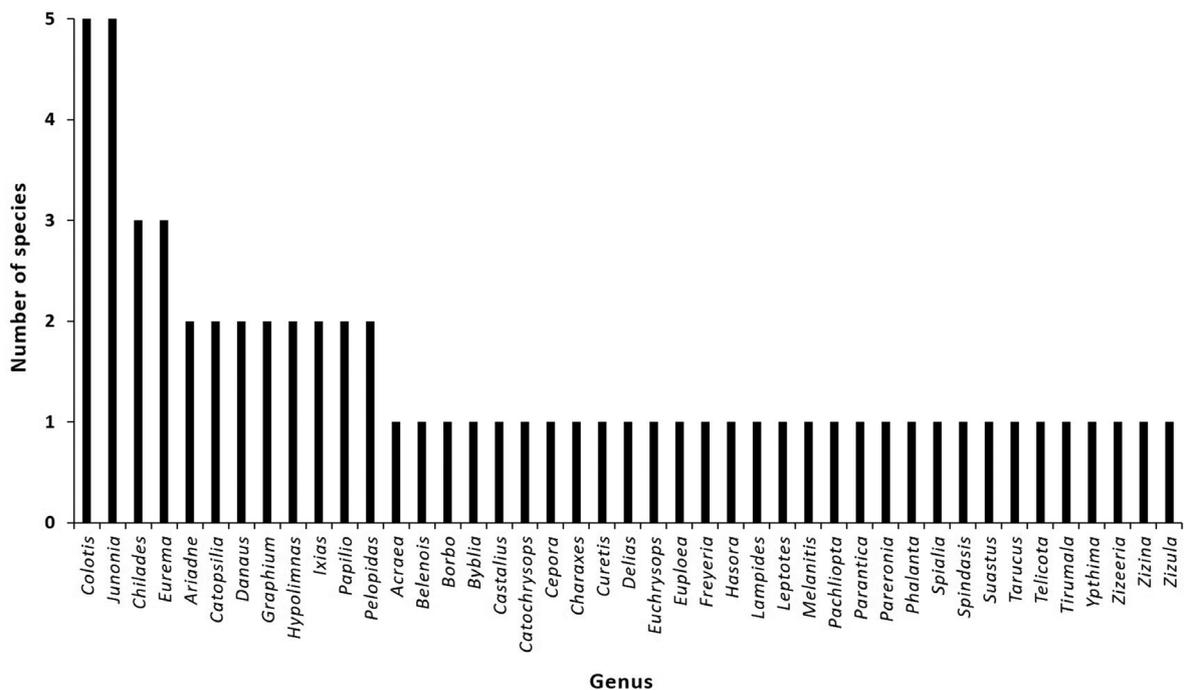
**Figure 2.** Species richness of butterfly families in the town of Ankleshwar, Gujarat, India.

**Table 1.** Transects surveyed for butterflies in the town of Ankleshwar, Gujarat, India.

Transect	Area	Geographic coordinates		Transect length (km)
		Start point	End point	
T-01	Agricultural fields of Piraman Village	21°37.01'N, 072°59.73'E	21°36.54'N, 072°36.54'E	1.43
T-02	Agricultural fields of Bhadi Village	21°33.00'N, 073°01.82'E	21°32.29'N, 073°32.29'E	1.48
T-03	Agricultural fields of Divi Village	21°39.04'N, 072°59.14'E	21°39.61'N, 073°39.61'E	2.65
T-04	Peripheral track of GIDC Pond	21°36.84'N, 073°00.42'E	21°36.83'N, 073°36.83'E	2.36
T-05	Suburban area near Taibah Nagar	21°37.49'N, 072°59.03'E	21°37.40'N, 072°37.40'E	1.20
T-06	Suburban area near Jitali Village	21°37.96'N, 073°03.47'E	21°37.36'N, 073°37.36'E	1.23
T-07	Peripheral track of GSFC Pond	21°38.99'N, 073°01.05'E	21°38.63'N, 073°38.63'E	3.10
T-08	Agricultural fields of Kapodara Village	21°34.43'N, 073°01.13'E	21°35.24'N, 073°35.24'E	1.72
T-09	Agricultural fields of Amboli Village	21°36.64'N, 072°57.63'E	21°35.57'N, 072°35.57'E	2.50
T-10	Peripheral area of Sanjali Industrial Zone	21°33.87'N, 072°58.38'E	21°32.98'N, 072°32.98'E	1.70

**Table 2.** Butterfly diversity and its status in the town of Ankleshwar, Gujarat, India. Abbreviations: WPA = Wildlife Protection Act, 1972; IUCN = International Union for Conservation of Nature; NE = Not Evaluated; LC = Least Concern.

Scientific Name	IUCN	WPA	Scientific Name	IUCN	WPA
Family Papilionidae			<i>Pareronia hippia</i> (Fabricius, 1787)		
<i>Graphium doson</i> (C. & R. Felder, 1864)	NE		<i>Ixias marianne</i> (Cramer, 1779)	NE	
<i>Graphium agamemno</i> (Linnaeus, 1758)	NE		<i>Ixias pyrene</i> (Linnaeus, 1764)	NE	
<i>Pachliopta aristolochiae</i> (Fabricius, 1775)	LC		<i>Colotis aurora</i> (Cramer, 1780)	NE	
<i>Papilio demoleus</i> Linnaeus, 1758	NE		<i>Colotis danae</i> (Fabricius, 1775)	NE	
<i>Papilio polytes</i> Linnaeus, 1758	NE		<i>Colotis fausta</i> (Olivier, 1804)	NE	
Family Nymphalidae			<i>Colotis amata</i> (Fabricius, 1775)	NE	
<i>Danaus chrysippus</i> (Linnaeus, 1758)	LC		<i>Colotis vestalis</i> (Butler, 1876)	NE	
<i>Danaus genutia</i> (Cramer, 1779)	NE		<i>Belenois aurota</i> (Fabricius, 1793)	NE	
<i>Tirumala limniace</i> (Cramer, 1775)	NE		<i>Cepora nerissa</i> (Fabricius, 1775)	NE	Schedule II - Part II
<i>Parantica aglea</i> (Stoll, 1782)	NE	Schedule II - Part II	Family Lycaenidae		
<i>Euploea core</i> (Cramer, 1780)	LC	Schedule IV	<i>Curetis thetis</i> (Drury, 1773)	NE	
<i>Melanitis leda</i> (Linnaeus, 1758)	NE		<i>Castalius rosimon</i> (Fabricius, 1775)	NE	Schedule I - Part IV
<i>Phalanta phalantha</i> (Drury, 1773)	NE		<i>Tarucus nara</i> (Kollar, 1848)	NE	
<i>Acraea terpsicore</i> (Linnaeus, 1758)	NE		<i>Euchrysops cnejus</i> (Fabricius, 1798)	NE	Schedule II - Part II
<i>Charaxes Solon</i> (Fabricius, 1793)	NE		<i>Catochrysops strabo</i> (Fabricius, 1793)	NE	
<i>Ariadne merione</i> (Cramer, 1777)	NE		<i>Zizeeria karsandra</i> (Moore, 1865)	LC	
<i>Ariadne ariadne</i> (Linnaeus, 1763)	NE		<i>Zizina otis</i> (Fabricius, 1787)	NE	
<i>Byblia ilithyia</i> (Drury, 1773)	NE		<i>Zizula hylax</i> (Fabricius, 1775)	NE	
<i>Junonia iphita</i> (Cramer, 1779)	NE		<i>Lampides boeticus</i> (Linnaeus, 1767)	LC	Schedule II - Part II
<i>Junonia orithya</i> (Linnaeus, 1758)	NE		<i>Chilades parrhasius</i> (Fabricius, 1793)	NE	
<i>Junonia atlites</i> (Linnaeus, 1763)	NE		<i>Chilades pandava</i> (Horsfield, 1829)	NE	
<i>Junonia lemonias</i> (Linnaeus, 1758)	NE		<i>Chilades lajus</i> (Stoll, 1780)	NE	
<i>Junonia almana</i> (Linnaeus, 1758)	LC		<i>Freyeria putli</i> (Kollar, 1844)	NE	
<i>Hypolimnas misippus</i> (Linnaeus, 1764)	NE	Schedule I - Part IV	<i>Leptotes plinius</i> (Fabricius, 1793)	NE	
<i>Hypolimnas bolina</i> (Linnaeus, 1758)	NE		<i>Spindasis vulcanus</i> (Fabricius, 1775)	NE	
<i>Ypthima huebneri</i> Kirby, 1871	NE		Family Hesperidae		
Family Pieridae			<i>Borbo cinnara</i> (Wallace, 1866)	NE	
<i>Catopsilia pomona</i> (Fabricius, 1775)	NE		<i>Pelopidas subochracea</i> (Moore, 1878)	NE	
<i>Catopsilia pyranthe</i> (Linnaeus, 1758)	NE		<i>Pelopidas mathias</i> (Fabricius, 1798)	NE	
<i>Eurema hecabe</i> (Linnaeus, 1758)	NE		<i>Hasora chromus</i> (Cramer, 1780)	NE	
<i>Eurema brigitta</i> (Stoll, 1780)	NE		<i>Suastus gremius</i> (Fabricius, 1798)	NE	
<i>Eurema laeta</i> (Boisduval, 1836)	NE		<i>Telicota colon</i> (Fabricius, 1775)	NE	
<i>Delias eucharis</i> (Drury, 1773)	NE		<i>Spialia galba</i> (Fabricius, 1793)	NE	



**Figure 3.** The number of butterflies in each genus in the town of Ankleshwar, Gujarat, India.

***Graphium doson* (C. & R. Felder, 1864)**

Common Jay

Figure 4A

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Black butterfly with pale blue, partially transparent central band of large spots and marginal row of smaller spots along the band; underside brown with similar but whitish markings; hindwing tail short.

***Graphium agamemnon* (Linnaeus, 1758)**

Tailed Jay

Figure 4B

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Black butterfly with green spots and streaks on the wings; underside wing with pale brown with black; red tonal spot on under hindwing; hindwing tail short.

***Pachliopta aristolochiae* (Fabricius, 1775)**

Common Rose

Figure 4C

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-03, T-04, T-08, T-09 (Table 1); agricultural hedges or barren/discarded lands, and near ponds with surrounding wetland plants.

**Identification.** Black red bodied butterfly; forewing elongated and black on both sides with paler greyish stripes in distal part of cell and between veins; hindwing tailed with white area made of five elongated spots.

***Papilio demoleus* Linnaeus, 1758**

Lime Swallowtail

Figure 4D

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-07, T-08, T-09 (Table 1); agricultural hedges or barren/discarded lands, and near ponds with surrounding wetland plants.

**Identification.** Tail-less hindwings; black butterfly with yellow spots; marginal and terminal rows of yellow spots on both wings on the upperside; abdomen lemon yellow with longitudinal black lines.

***Papilio polytes* Linnaeus, 1758**

Common Mormon

Figure 4E

**Material examined.** INDIA • Gujarat, Bharuch district,

Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Jet black butterfly with row of white spots along the central region of the hindwing; series of smaller white spots on the margin of forewing.

Family Nymphalidae

Commonly known as brush-footed butterflies; species have legs covered with long hairs and forelegs reduced; migrant and powerful fliers.

***Danaus chrysippus* (Linnaeus, 1758)**

Plain Tiger

Figure 4F

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Pale orange with black marginal borders; upper forewing with black tips and a sub-apical white band of elongated spots; devoid of bold outlines to veins, hindwings with 3 or 4 discal spots on both sides; thorax black with white spots.

***Danaus genutia* (Cramer, 1779)**

Striped Tiger

Figure 4G

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-03, T-09 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Tawny with black bold veins, margins black with small white spots along border; broad black apex with white elongated subapical spots; underside paler but similar to upperside.

***Tirumala limniace* (Cramer, 1775)**

Blue Tiger

Figure 4H

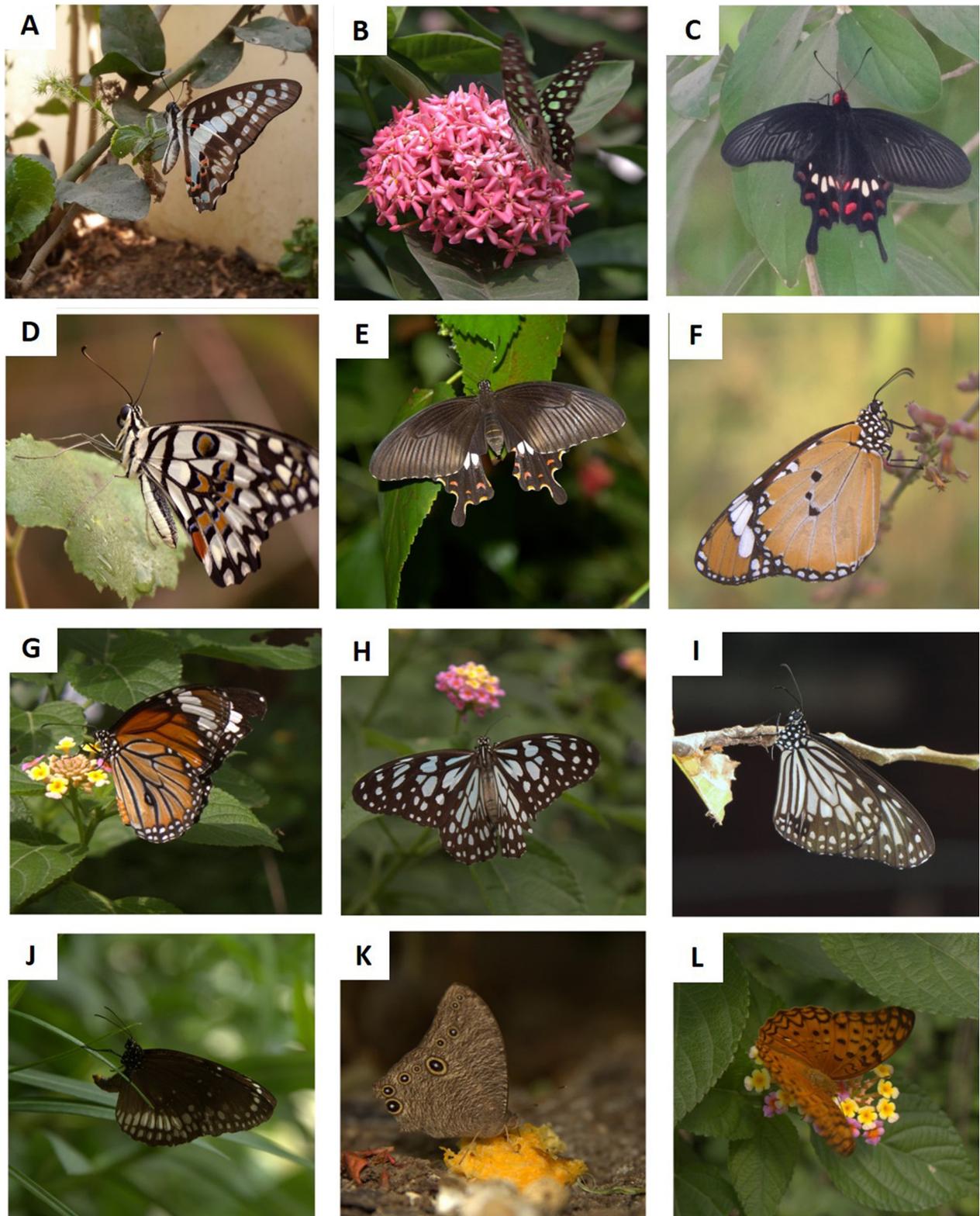
**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-03, T-07 (Table 1); agricultural hedges or barren/discarded lands, and near ponds with surrounding wetland plants.

**Identification.** Pale-blue streaks and spots against black or brown background; underside hindwing with pale or white cell, with thin black narrow forked streak in the middle; males smaller than females; characteristic flat pendulous pouch near the cell of the hindwing, which contains scent scales.

***Parantica aglea* (Stoll, 1782)**

Glassy Tiger

Figure 4I



**Figure 4.** Butterfly species recorded in the town of Ankleshwar, Gujarat, India. **A.** *Graphium doson*. **B.** *Graphium agamemno*. **C.** *Pachliopta aristolochiae*. **D.** *Papilio demoleus*. **E.** *Papilio polytes*. **F.** *Danaus chrysippus*. **G.** *Danaus genutia*. **H.** *Tirumala limniace*. **I.** *Parantica aglea*. **J.** *Euploea core*. **K.** *Melanitis leda*. **L.** *Phalanta phalantha*.

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transect number T-09 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Upperside brown with bluish-white, transparent markings; forewing with pale streak in cell, divided by two dark lines; underlings paler.

***Euploea core* (Cramer, 1780)**

Common Crow

Figure 4J

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural

hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Under forewing with a spot at end of cell, a spot near leading edge, three central spots bluish white. Under hindwing with bluish white spot at end of cell with five or six central spots beyond. Male with small brand along the inner edge on upper forewing.

***Melanitis leda* (Linnaeus, 1758)**

Common Evening Brown

Figure 4K

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Large, brown butterfly; brown upper-side; upperside forewings with an eyespot and white pupil surrounded by orange patches; dry season forms with angular apex of forewings.

***Phalanta phalantha* (Drury, 1773)**

Common Leopard

Figure 4L

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-08 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Bright, tawny butterfly marked with black spots; pale and glossy underside; dry season form purple and glossy on the underside.

***Acraea terpsicore* (Linnaeus, 1758)**

Tawny Coster

Figure 5A

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Bright, tawny red butterfly; small thorax; long and narrow abdomen; forewings and hindwings tawny red with black border; broader black border on the hindwings and a series of white spots; long and broad forewings with rounded apex; round hindwings.

***Charaxes solon* (Fabricius, 1793)**

Black Rajah

Figure 5B

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transect number T-03 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Tailed hindwings; black to brown upper-side with row of closely spaced yellowish-green discal spots on both wings; upper forewing with broken row of

spots towards apex; presence of submarginal and marginal small spots; silvery grey with narrow black wavy lines on underside; underside hindwing with submarginal and marginal yellowish-green spots; faint submarginal spots on under forewings.

***Ariadne merione* (Cramer, 1777)**

Common Castor

Figure 5C

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-08, T-09 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Rusty-brown forewings and hindwings on the upperside; double and wavy discal line on upper-side; apex at upper forewings slightly squarish; grayish-brown with dark brown narrow bands on the underside.

***Ariadne ariadne* (Linnaeus, 1763)**

Angled Castor

Figure 5D

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transect number T-09 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Similar to *Ariadne merione*, but dark, with regular black lines; forewing termen deeply concave; darker brown with purplish-brown markings on the underside; discal line beyond cell angled in upper forewings.

***Byblia ilithyia* (Drury, 1773)**

Joker

Figure 5E

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Bright, tawny-colored butterfly; narrow black markings in male and dark brown in females; black outer discal band broken at vein 5 on upper forewing, black termen and under hindwing with white basal and central band.

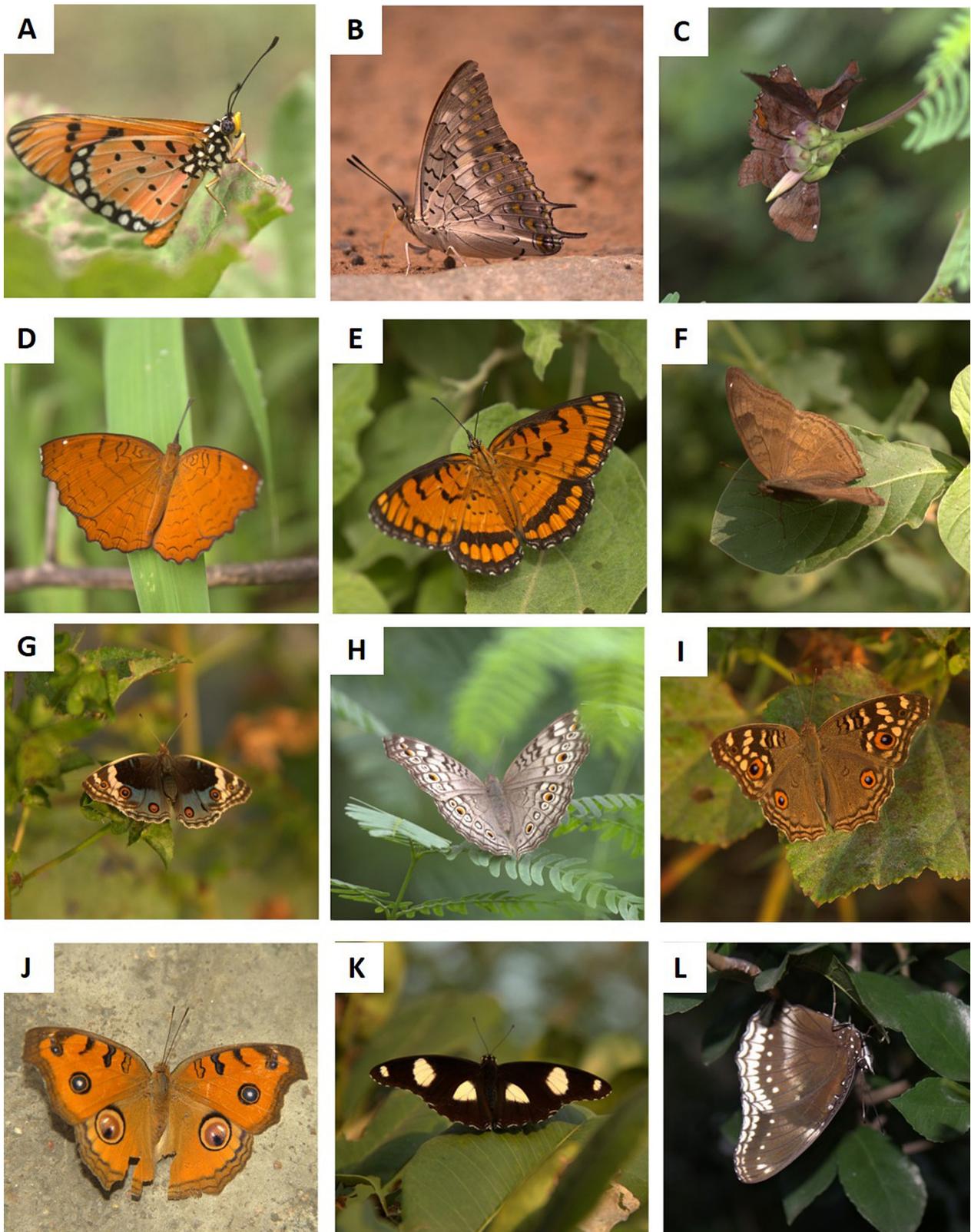
***Junonia iphita* (Cramer, 1779)**

Chocolate Pansy

Figure 5F

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Pale- to dark-brown upperside with dark-brown bands; a series of small eyespots on upper hindwings; upper forewings with or without small eyespots; leaf-like underside.



**Figure 5.** Butterfly species recorded in the town of Ankleshwar, Gujarat, India. **A.** *Acraea terpsicore*. **B.** *Charaxes solon*. **C.** *Ariadne merione*. **D.** *Ariadne ariadne*. **E.** *Byblia ilithyia*. **F.** *Junonia iphita*. **G.** *Junonia orithya*. **H.** *Junonia atlites*. **I.** *Junonia lemonias*. **J.** *Junonia almanac*. **K.** *Hypolimnna misippus*. **L.** *Hypolimnna bolina*.

***Junonia orithya* (Linnaeus, 1758)**

Blue Pansy

Figure 5G

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-04, T-06, T-10

(Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Upper hindwings bright blue; apex pale brown with white bands on the upper forewings; shiny

blue in outer discal area below apex in upper forewings.

***Junonia atlites* (Linnaeus, 1763)**

Grey Pansy

Figure 5H

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-02, T-08 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Grey with dark brown lines on the upperside; a series of discal eyespots on upperside of both wings.

***Junonia lemonias* (Linnaeus, 1758)**

Lemon Pansy

Figure 5I

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Several eyespots on brown wings; upper forewings and hindwings with black and lemon-yellow spots.

***Junonia almana* (Linnaeus, 1758)**

Peacock Pansy

Figure 5J

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-02, T-03, T-05, T-06, T-08, T-09 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, and roadside vegetation.

**Identification.** Tawny orange with prominent eyespots on upperside of both wings; large eyespot on upper hindwings; two smaller eyespots on upper forewings; squarish apex and concave termen of upper forewings; upperside with three narrow black lines borders on both pair of wings.

***Hypolimnias misippus* (Linnaeus, 1764)**

Danaid Eggfly

Figure 5K

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-05, T-06, T-07, T-08, T-09 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Males jet black with two large spots, one on hindwing larger and one small on forewing smaller; small white spot on upperside forewing; golden yellow-tinged, light, rusty brown underside; narrow white band on underside forewing and broad one at hindwing. Females mimic *Danaus chrysippus*; forewing apex black with white band; black-bordered hindwings with a series of white spots

***Hypolimnias bolina* (Linnaeus, 1758)**

Great Eggfly

Figure 5L

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-06, T-09 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, and roadside vegetation.

**Identification.** Males upperside black, with white centred, iridescence blue oval spots on each wing; upper hindwing spot larger; row of big white spots along margin from apex to tornus on upperside. Females with broader wings; dark brown without discal row of small white spots on upperside forewings and hindwings; mimic *Euploea core*.

***Ypthima huebneri* Kirby, 1871**

Common Four-ring

Figure 6A

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-03, T-06, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, and roadside vegetation.

**Identification.** Pale brown or whitish underside, with brown streaks; underside forewing with large eyespot enclosed in a golden yellow ring; underside hindwing with six eye spots in three pairs; upperside forewing with distinct eyespot visible during basking.

Family Pieridae

Commonly known as Whites and Yellows; species with wings mainly white or yellow, with red, orange, yellow or black markings.

***Catopsilia pomona* (Fabricius, 1775)**

Lemon Emigrant

Figure 6B

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** A most variable butterfly species; wings vary from white to lemon-yellow; bases of all wings yellow on upperside.

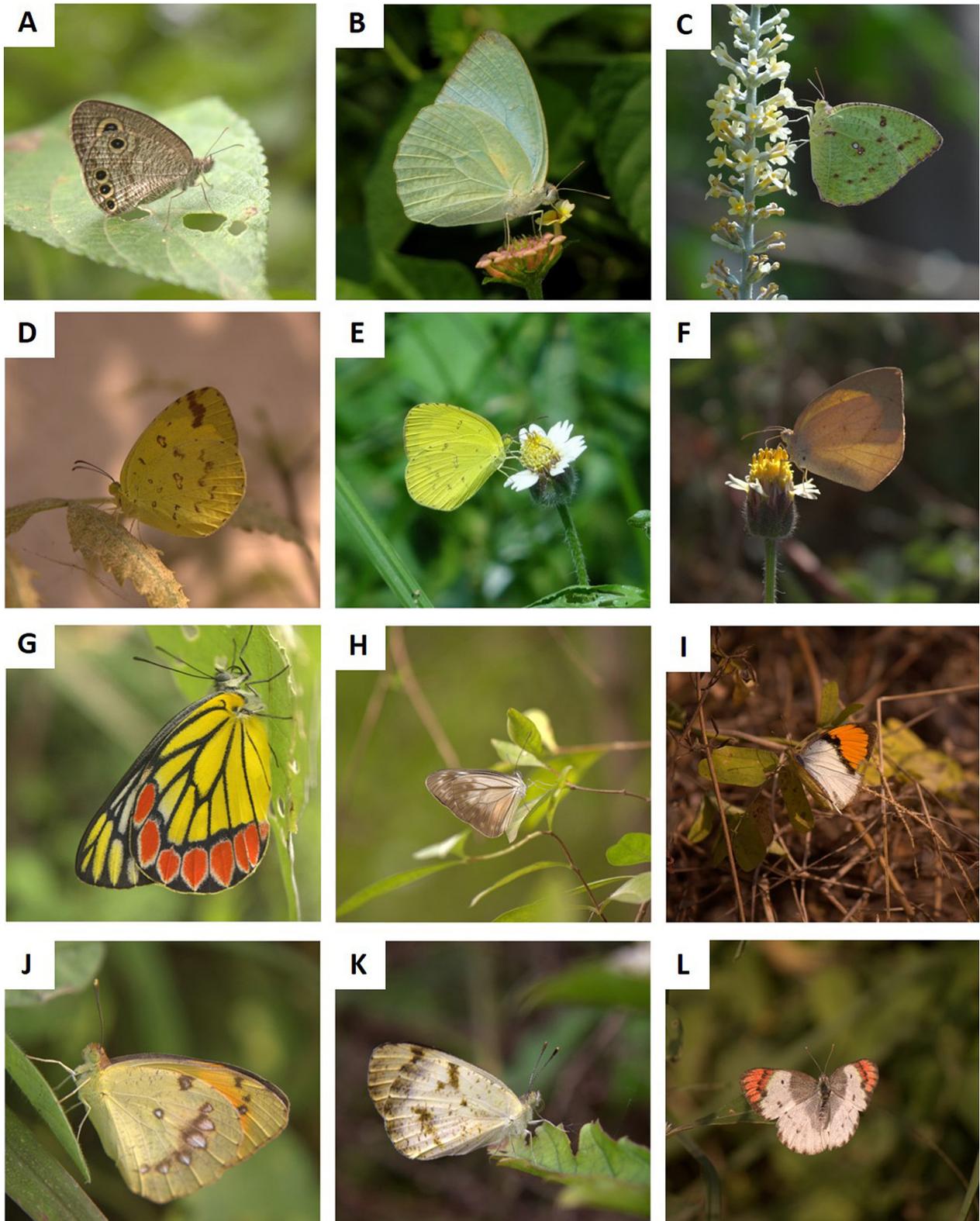
***Catopsilia pyranthe* (Linnaeus, 1758)**

Mottled Emigrant

Figure 6C

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-07, T-09 (Table 1); agricultural hedges or barren/discarded lands, and near ponds with surrounding wetland plants.

**Identification.** White to greenish-yellow; upperside dull white; underside mottled with light-brown or green lines; under hindwings with or without distinct red-ringed



**Figure 6.** Butterfly species recorded in the town of Ankleshwar, Gujarat, India. **A.** *Ypthima huebneri*. **B.** *Catopsilia pomona*. **C.** *Catopsilia pyranthe*. **D.** *Eurema hecabe*. **E.** *Eurema brigitta*. **F.** *Eurema laeta*. **G.** *Delias eucharis*. **H.** *Pareronia hippie*. **I.** *Ixias marianne*. **J.** *Ixias pyrene*. **K.** *Colotis aurora*. **L.** *Colotis danae*.

silver spots at centre. Upperside of dry season forms with reddish-brown to blackish markings.

***Eurema hecabe* (Linnaeus, 1758)**

Common Grass Yellow

Figure 6D

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Bright yellow; brown blotches on the underside of forewing; apex and termen broadly black on upper forewing; narrow black terminal border on upper hindwing.

***Eurema brigitta* (Stoll, 1780)**

Small Grass Yellow

Figure 6E

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-05, T-06, T-08, T-09 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, and roadside vegetation.

**Identification.** Bright yellow; outer margin and apex broadly black with inner border edge evenly curved along costa; broadly and narrowly black on outer margin of upper hindwing.

***Eurema laeta* (Boisduval, 1836)**

Spotless Grass Yellow

Figure 6F

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-09 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Yellow with distinct seasonal dimorphism. Wet season form: upper forewing apex and termen broadly black, inner edge unevenly rounded and scalloped, upper hindwing with narrow terminal black borders and under forewing with a small black spot at end-cell; female with broader borders and denser black dusting on underside. Dry season form: forewings apex pointed, pale yellow underside with overlaid with light brown scales, with a darker oblique line; upperside wings bright yellow in both sexes.

***Delias eucharis* (Drury, 1773)**

Indian Jezebel

Figure 6G

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** White upperside, bright yellow with black veins underside; underside with marginal series of somewhat pentagonal, orange-red spots.

***Pareronia hippia* (Fabricius, 1787)**

Indian Wanderer

Figure 6H

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-03 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Pale blue or bluish-white on upperside in males; prominent marginal spots increase in size towards apex, and black margins on upper forewings.

Female whitish with marginal markings less blue, prominent on upper hindwing.

***Ixias marianne* (Cramer, 1779)**

White Orange-tip

Figure 6I

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Upperside white with broad black borders; upperside forewings with black apical band that encloses orange patch; black terminal border on upper hindwings; row of black spots in orange portion in females.

***Ixias pyrene* (Linnaeus, 1764)**

Yellow Orange-tip

Figure 6J

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Male upperside yellow with black apical half enclosing a large orange band on forewing; upper hindwing with black border; Underside yellow in both sexes with brown blotches; female white or yellow on upperside; white female with white apical band; upperside black areas more extensive, yellow female with apical band reduced in size and bearing two black spots; white form common in southern India.

***Colotis aurora* (Cramer, 1780)**

Plain Orange-tip

Figure 6K

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Male upperside white, upper forewing with broad orange-yellow apical patch with black outer border, upper hindwing usually with marginal black vein spots; female upper forewing black apical area enclosing three or four elongate, orange or pale-yellow spots.

***Colotis danae* (Fabricius, 1775)**

Crimson-tip

Figure 6L

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-07, T-08, T-09 (Table 1); agricultural hedges or barren/

discarded lands, suburban areas, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Male upperside white, with inwardly black-bordered, broad, bright crimson tip on upper forewing; upper hindwing with black band or spots along outer edge; female upperside with dark dusting at base of both wings; upper forewing with much reduced and paler crimson area crossed by a line of small black spots; under hindwing white or pale yellowish with a central band of black spots; in both sexes, under forewing yellowish, apical area pink-tinged with a row of dark reddish black spots.

***Colotis fausta* (Olivier, 1804)**

Large Salmon Arab

Figure 7A

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-05, T-07, T-08, T-09 (Table 1); agricultural hedges or barren/discarded lands, and near ponds with surrounding wetland plants.

**Identification.** Male upperside pale to deep salmon pink with upper forewing having black cell spot, broad black apex bearing spots of ground color, and terminal border narrow to a point at or near tornus, upper hindwing with marginal black spots, upper forewing with brand; female with dimorphic, white upperside with black margins, a distinctive spot at the subapical area of forewing. Antennae, head, thorax, and abdomen dusky black.

***Colotis amata* (Fabricius, 1775)**

Small Salmon Arab

Figure 7B

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Underside greenish yellow; salmon pink upperside; black costal border touches black spot at end cell; and apical half bearing spots of ground color on upper forewing; similar spotting on dark outer border on upper hindwing.

***Colotis vestalis* (Butler, 1876)**

White Arab

Figure 7C

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-10 (Table 1); agricultural hedges or barren/discarded lands, industrial zone, and roadside vegetation.

**Identification.** Prominent white spot on broad black outer border and two or three white spots on black apex of upper forewing; no white spots on terminal border of upper hindwing; upper forewing with dark cell spot and streak above cell; outer borders brownish-black in female.

***Belenois aurota* (Fabricius, 1793)**

Pioneer

Figure 7D

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Distinct “hockey stick” mark at front margin of forewings; white with apical black margins on upperside; unmarked hindwings except at margin; bright yellow with marginal markings and black bands along veins on underside.

***Cepora nerissa* (Fabricius, 1775)**

Common Gull

Figure 7E

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-05, T-08, T-09 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Male upper forewing white with dusky vein marks; black border along outer edge often with white spots; female upperside with extensive black markings and dark veins; underside whitish yellow with black veins; under forewing white, yellow apex and leading edge; under hindwing pale or dark yellow; wet season forms are bright yellow and deep black, whereas dry season forms are yellow to pale brown.

Family Lycaenidae

Commonly known as Blues; majority of species have blue uppersides and threadlike tails; forelegs are non-functional due to their small size.

***Curetis thetis* (Drury, 1773)**

Indian Sunbeam

Figure 7F

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transect number T-01 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Tailless; underside glossy white with no small black dots other than in bands or lines; central and marginal lines parallel to one another and to outer wing margin, and consist of short lines; hindwing outer edge evenly rounded; upperside golden red in males and orange discal patches in females.

***Castalius rosimon* (Fabricius, 1775)**

Common Pierrot

Figure 7G

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas,



**Figure 7.** Butterfly species recorded in the town of Ankleshwar, Gujarat, India. **A.** *Colotis fausta*. **B.** *Colotis amata*. **C.** *Colotis vestalis*. **D.** *Belenois aurota*. **E.** *Cepora nerissa*. **F.** *Curetis thetis*. **G.** *Castalius rosimon*. **H.** *Tarucus nara*. **I.** *Euchrysops cnejus*. **J.** *Catochrysops strabo*. **K.** *Zizeeria karsandra*. **L.** *Zizina otis*.

industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** White-tipped black-tailed hindwings; underside marked with black spots and streaks on white;

under forewing with square black spots; metallic green spot at tornus in underside hindwing; white upperside with dark borders and black spots along with metallic blue scales in basal area.

***Tarucus nara* (Kollar, 1848)**

Striped Pierrot

Figure 7H

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Hindwings with tail; underside wing white with prominent black streak in under forewing cell, and black marks elongated into streaks rather than rounded spots. Males dull violet-blue on upperside, with a cell spot but no other discal spots on upper forewings; females dull brown on upperside.

***Euchrysops cnejus* (Fabricius, 1798)**

Gram Blue

Figure 7I

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Tailed hindwing; underside hindwings with orange-crowned black tornal spots with metallic silver centres, one on either side; males pale violet-blue on upperside and females brown on upperside with slight blue scaling at bases of both wings.

***Catochrysops strabo* (Fabricius, 1793)**

Forget-me-not

Figure 7J

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-05, T-07, T-08, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Tailed hindwing; narrow wings; underside with pale grey with white-edged fawn discal bars; underside forewings with small pale costal spot, near discal bar; two white ringed black spots along costa and two black tornal spots; underside hindwing with large yellow-crowned tornal spot above tail.

***Zizeeria karsandra* (Moore, 1865)**

Dark Grass Blue

Figure 7K

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-07, T-08, T-09 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Tailless hindwing; underside greyish brown with small, rounded black spots; upperside dark blue.

***Zizina otis* (Fabricius, 1787)**

Lesser Grass Blue

Figure 7L

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Tailless hindwing; underside pale grayish brown with rounded and pale dark spots; underside forewing devoid of costal spots or any spot inside cell. Underside hindwing: first two spots from costa separate, third to sixth spots form a curve, and seventh spot separate towards the termen.

***Zizula hylax* (Fabricius, 1775)**

Tiny Grass Blue

Figure 8A

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-07, T-08, T-09 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Tailless hindwing; underside pale greyish brown with fine, small, distinct, dark brown or black spots; underside with row of discal spots, separated and angled inwards and bar at end cell, no spot in mid-cell; underside hindwing with two costal spots and spot near end cell; spot present in the cell next to two more spots near base.

***Lampides boeticus* (Linnaeus, 1767)**

Pea Blue

Figure 8B

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

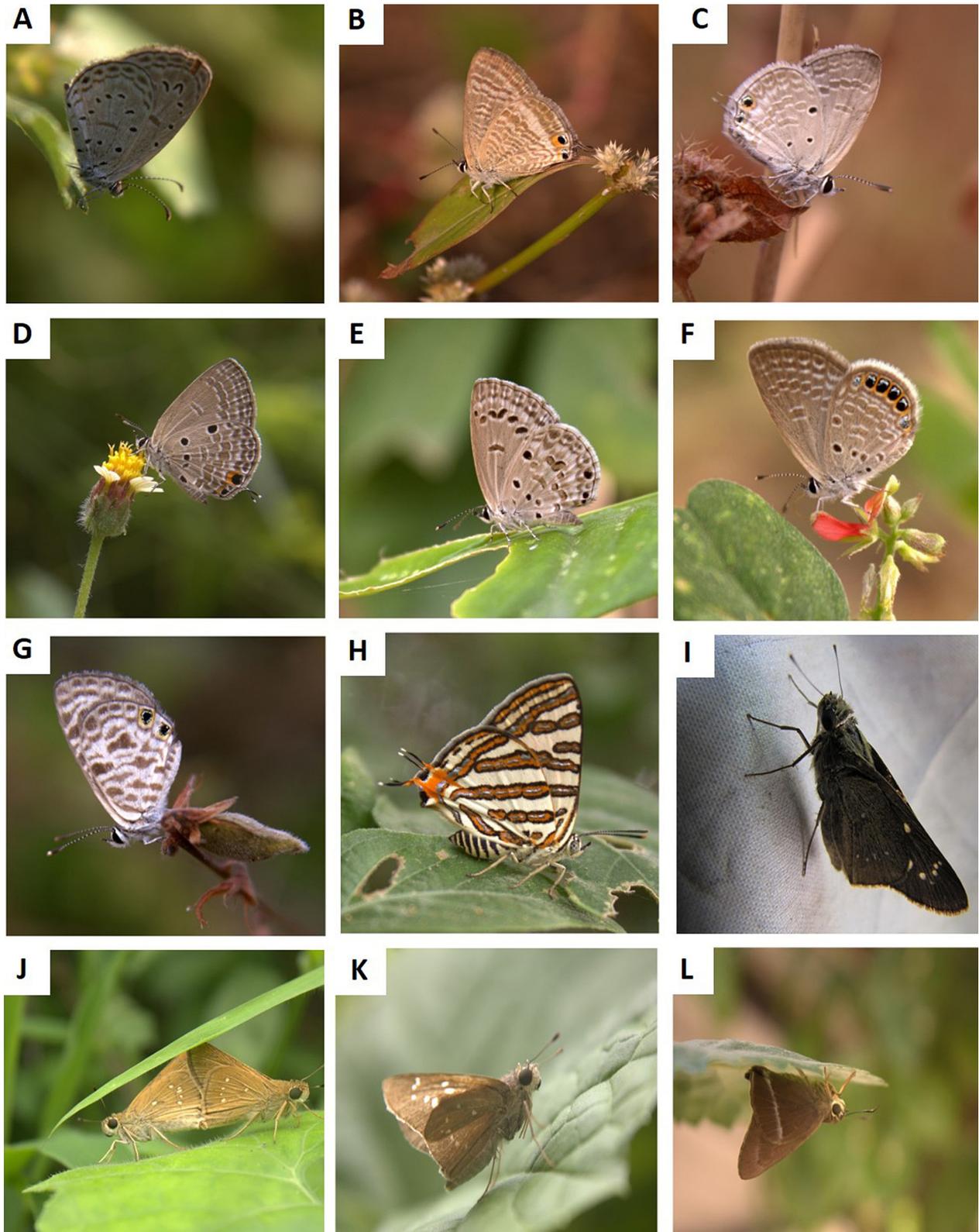
**Identification.** Long, white-tipped, tailed hindwing; white underside with light or dark reddish line; distinct white band within outer margin of hindwing, where the lines are absent; underside forewing with no spots; underside hindwing with two orange-ringed black tornal spots, with metallic silver crown.

***Chilades parrhasius* (Fabricius, 1793)**

Small Cupid

Figure 8C

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.



**Figure 8.** Butterfly species recorded in the town of Ankleshwar, Gujarat, India. **A.** *Zizula hylax*. **B.** *Lampides boeticus*. **C.** *Chilades parrhasius*. **D.** *Chilades pandava*. **E.** *Chilades lajus*. **F.** *Freyeria putli*. **G.** *Leptotes plinius*. **H.** *Spindasis vulcanus*. **I.** *Borbo cinnara*. **J.** *Pelopidas subochracea*. **K.** *Pelopidas mathias*. **L.** *Hasora chromus*.

**Identification.** Similar to *Chilades pandava* but with only three spots near under hindwing base. Upper black spot prominent and slightly larger than lower spot at lower tip on under hindwing.

***Chilades pandava* (Horsfield, 1829)**

Plains Cupid  
Figure 8D

**Material examined.** INDIA • Gujarat, Bharuch district,

Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** White-tipped tailed hindwing; underside with marginal and discal rows of linked spots, slightly brownish-grey; underside forewing with unbroken discal row of spots; underside forewings devoid of spot in cell; underside forewing with four spots near base.

***Chilades lajus* (Stoll, 1780)**

Lime Blue

Figure 8E

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Tailless hindwing; underside light with numerous dark spots; among these spots, one pair of spots on each wing are joined at right angles; upperside dull purplish-blue with thin, black border in males; females blackish brown with metallic blue wing bases.

***Freyeria putli* (Kollar, 1844)**

Black-Spotted Grass Jewel

Figure 8F

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-03 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Tailless; underside grey to light brown; two larger darker spots along leading edge of under hindwing, besides other spots; under hindwing has silver-edged black spots with orange crowns along outer edge, but the orange crowns are not as conspicuous as in *Freyeria putli*; both sexes dark brown on upperside; differs from *Freyeria putli* in being darker on upperside, with wings more elongate; lacking orange crowns on dark spots at lower tip on upper hindwing.

***Leptotes plinius* (Fabricius, 1793)**

Zebra Blue

Figure 8G

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Tailed hindwing; translucent wings; when wings open markings on underside can be seen through the upperside; underside with black and white “zebra” pattern; underside whitish with irregular, broad and narrow, alternating brown bands at right angles to costa.

***Spindasis vulcanus* (Fabricius, 1775)**

Common Silverline

Figure 8H

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transect number T-02 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Narrow and pointed wings; two large lobes and two long tails on hindwings; light yellow with brilliant red bands on the underside, bands are bordered with black lines on either side with central golden lines; upperside wings dark with orange bands.

Family Hesperiiidae

Commonly known as Skippers; species have stout bodies and hooked (apiculate) antennae; flight rapid.

***Borbo cinnara* (Wallace, 1866)**

Rice Swift

Figure 8I

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-05, T-06, T-08, T-09 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, and roadside vegetation.

**Identification.** Dark-brown wings with semitransparent spots on forewings; these spots decrease in size from lower margin towards upper margin of wing; white spots on underside of hindwings.

***Pelopidas subochracea* (Moore, 1878)**

Large Branded Swift

Figure 8J

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-06, T-08, T-09 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, and roadside vegetation.

**Identification.** Under hindwing with prominent white spots and one in cell, some may be absent; female with an additional spot near inner edge and a second smaller one above it on under forewing, spread over whitish area near under forewing inner edge; male upper forewing spots well marked, a prominent pale brand with the lower end of the brand nearer to base than to outer edge, no spot near inner edge, upper hindwing usually unmarked.

***Pelopidas mathias* (Fabricius, 1798)**

Small Branded Swift

Figure 8K

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-08 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Resembles *Pelopidas agna*, but lower central spots on upper forewing squarish, not linear; an imaginary straight line through two cell spots in male crosses brand near its midpoint; unlike *Pelopidas mathias*, male brand is black; upper hindwing may be pale or spotted; five small spots usually present and one in cell,

or none at all on under hindwing; grey patched in dry-season form on underside; female similar to *Pelopidas agna* and *Pelopidas subochracea*.

#### ***Hasora chromus* (Cramer, 1780)**

Common Banded Awl

Figure 8L

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-03 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Underside grey with purple glaze; hindwing with a transverse discal white band and black torus dot; eyes large and black; antennae black, hairy scales on and around head.

#### ***Suastus gremius* (Fabricius, 1798)**

Oriental Palm Bob

Figure 9A

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-04, T-05, T-06, T-07, T-08, T-09, T-10 (Table 1); agricultural hedges or barren/discarded lands, suburban areas, industrial zone, roadside vegetation, and near ponds with surrounding wetland plants.

**Identification.** Light brown with dark brown scales; prominent five black spots at central area of hindwing, three spots in one row and two others in one row; semi-transparent white spots on forewing.

#### ***Telicota colon* (Fabricius, 1775)**

Pale Palm-Dart

Figure 9B

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transects T-01, T-02, T-03, T-08, T-09 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Male with yellow veins on upper forewing, yellow color extends above each vein over upper forewing leading-edge; broad, grey band nearer to inner than outer edge of central black band on upper forewing; under hindwing pale greenish with well-defined band in wet-season form and pale yellow in dry-season form; upperside markings paler in female.

#### ***Spialia galba* (Fabricius, 1793)**

Asian Grizzled Skipper

Figure 9C

**Material examined.** INDIA • Gujarat, Bharuch district, Ankleshwar; transect number T-01 (Table 1); agricultural hedges or barren/discarded lands.

**Identification.** Small, with black and white “zebra” patches; upperside rich black marked with small white spots; underside with whitish border of hairy wing.

## Discussion

Our study focused mainly on producing a checklist of butterfly species in the industrial town of Ankleshwar, Gujarat, India. Urbanization directly threatens the butterfly diversity. Human activities have a strong influence on the biodiversity of all the existing species. Clark et al. (2007) showed that an increase in human activity is associated with a decrease in butterfly species and claimed that rare species were the most affected. Our observations confirm the presence of a wide variety of butterflies in areas of industries and human habitation.

The species richness of butterflies in other urban areas of India varies viz., Pune (103 species; Kunte 2001), Nagpur (145 species; Tiple and Khurad 2009), Jhansi (27 species; Kumar 2012), Itanagar (63 species; Sarma et al. 2012), Tropical Forest Research Institute in Jabalpur (66 species; Tiple 2012), Bilaspur (51 species; Kaneria et al. 2013), Jhagadia (58 species; Kumar 2013), Kumaun University in Nainital (27 species; Arya et al. 2014), Chennai (47 species; Thangapandian et al. 2014), Vadodara (43 species; Gandhi and Kumar 2015), Kolkata metropolis (54 species; Mukherjee et al. 2016), Arboretum in Vadodara (61 species; Bhatt and Nagar 2017), and Midnapore area in West Bengal (82 species; Biswas et al. 2019). In the present study, 63 species of butterflies are reported. The number of urban butterfly species varied in relation to the study site, survey method, and sampling effort. Among observed butterflies, Nymphalidae exhibited the greatest species richness, which corroborates studies elsewhere in India (Tiple and Khurad 2009; Chowdhury and Soren 2011; Majumder et al. 2012; Sarma et al. 2012; Kumar and Mattu 2014; Nair et al. 2014; Gandhi and Kumar 2015; Bhatt and Nagar 2017). However,



**Figure 9.** Butterfly species recorded in the town of Ankleshwar, Gujarat, India. **A.** *Suastus gremius*. **B.** *Telicota colon*. **C.** *Spialia galba*.

in contrast, at Simla (Thakur and Bhardwaj 2012), Jhagadia (Kumar 2013), and Kumaun Himalayas (Arya et al. 2014), Pieridae was the dominant family.

Our study area has a rich diversity of butterflies species, including seven rare and threatened species listed under the Indian Wildlife Protection Act, 1972, for which conservation is necessary to avoid regional extirpation. Butterfly diversity is largely dependent on floral richness because larval host-plants associations are often specific (Murphy and Wilcox 1986). The conservation of butterfly diversity can, therefore, be achieved by enhancing vegetation in habitats specifically preferred by butterflies (Lawton et al. 1998). The protection of nectar and host-plant patches near the periphery of the city and industry is therefore required, as the distribution of host-plants have a maximum impact on butterfly diversity (Raju et al. 2004). Artificial structures and human habitations can also help by creating a habitat that significantly helps to protect butterfly populations. The data on the butterflies in and around Ankleshwar presented here can serve as a baseline reference for similar future studies. Research on interactions of butterflies with specific host-plants, distribution of butterfly species, and priority areas for butterfly conservation will all be helpful to better understanding the conservation needs of these invertebrates and the ecosystem as a whole.

## Acknowledgements

We thank Prof. Arun Arya for helping with fieldwork and providing necessary guidance throughout our research. We are also grateful to Mayank Katariya, Bhuvnesh Bhatt, Dimpi Patel, Ashish Jangid, Aashna Sharma, Karan Rana, and Shrushti Modi for their help in the preparation of the map and worthwhile suggestions. Lastly, we thank the reviewers and editors for their invaluable comments and suggestions, which helped improve our manuscript.

## Authors' contributions

AS planned the work, designed the study, conducted field sampling and data collection, prepared map and tables, approved the final draft; UB conceived and designed the study, prepared tables and figures, analyzed and interpreted the data, authored and reviewed the drafts, approved the final draft.

## References

- Anonymous (2006) The Wildlife (Protection) Act, 1972. Natraj Publishers, Dehradun, 235 pp.
- Arya MK, Dayakrishna, Chaudhary R (2014) Species richness and diversity of butterflies in and around Kumaun University, Nainital, Uttarakhand, India. *Journal of Entomology and Zoology Studies* 2 (3): 153–159.
- Bhatt U, Nagar P (2017) Diversity of butterflies in an arboretum of Vadodara, Gujarat, India. *Check List* 13 (2): 2073. <https://doi.org/10.15560/13.2.2073>
- Biswas SJ, Patra D, Roy S, Giri SK, Paul S, Hossain A (2019) Butterfly diversity throughout Midnapore urban area in West Bengal, India. *Journal of Threatened Taxa* 11 (14): 14816–14826. <https://doi.org/10.11609/jott.4587.11.14.14816-14826>
- Brattstrom O, Kjellen N, Alerstam T, Akesson S (2008) Effects of wind and weather on the red admiral, *Vanessa atalanta*, migration at a coastal site in southern Sweden. *Animal Behavior* 76 (2): 335–344. <https://doi.org/10.1016/j.anbehav.2008.02.011>
- Chowdhury S, Soren R (2011) Butterfly (Lepidoptera: Rhopalocera) fauna of East Calcutta Wetlands, West Bengal, India. *Check List* 7 (6): 700–703. <https://doi.org/10.15560/10960>
- Clark PJ, JM Reed, FS Chew (2007) Effects of urbanization on butterfly species richness, guild structure, and rarity. *Urban Ecosystems* 10 (3): 321–337. <https://doi.org/10.1007/s11252-007-0029-4>
- Evans WH (1932) The identification of Indian butterflies, 2nd edition. The Diocesan Press, Madras, 464 pp.
- Gandhi S, Kumar D (2015) Studies on butterfly diversity, abundance, and utilization of plant resources in urban localities of Banyan city-Vadodara, Gujarat, India. *Journal of Entomology and Zoology Studies* 3 (4): 476–480.
- Garg RK, Rao RJ, Saksena DN (2009) Water quality and conservation management of Ramsagar reservoir, Datia, Madhya Pradesh. *Journal of Environmental Biology* 30 (5): 909–916.
- Gay T, Kehimkar ID, Punetha JC (1992) Common butterflies of India. Oxford University Press, Bombay, 67 pp.
- IMD (2017) Indian Meteorological Department (Ministry of Earth Sciences, Govt. of India) – Annual Report. Information Science & Knowledge Resource Development Division, New Delhi, India, 144 pp.
- IMD (2018) Indian Meteorological Department (Ministry of Earth Sciences, Govt. of India) – Annual Report. Information Science & Knowledge Resource Development Division, New Delhi, India, 152 pp.
- IUCN (2020) IUCN Red List of threatened species, version 2020-1. <http://www.iucnredlist.org>. Accessed on: 2020-5-3.
- Kaneria M, Kaneria M, Kushwah V (2013) Diversity of butterflies (Lepidoptera) in Bilaspur district, Chhattisgarh, India. *Asian Journal of Experimental Biological Sciences* 4 (2): 282–287.
- Kehimkar I (2016) Butterflies of India. (BNHS Field Guides). Bombay Natural History Society, Mumbai, 516 pp.
- Koh LP (2007) Impacts of land use change on South-east Asian forest butterflies: a review. *Journal of Applied Ecology* 44 (4): 703–713. <https://doi.org/10.1111/j.1365-2664.2007.01324.x>
- Kuhn E, Feldmann R, Harpke A, Hirneisen N, Musche M, Leopold P, Settele J (2008) Getting the public involved in butterfly conservation: lessons learned from a new monitoring scheme in Germany. *Israel Journal of Ecology and Evolution* 54 (1): 89–103. <https://doi.org/10.1560/IJEE.54.1.89>
- Kumar A (2012) A report on the butterflies in Jhansi (U.P.) India. *Journal of Applied and Natural Science* 4 (1): 51–55. <https://doi.org/10.31018/jans.v4i1.221>
- Kumar A (2013) Butterfly (Lepidoptera: Insecta) diversity from different sites of Jhagadia, Ankleshwar, district-Bharuch, Gujarat. *Octa Journal of Environmental Research* 1 (1): 09–18.
- Kumar R, Mattu VK (2014) Diversity of butterflies (Lepidoptera: Insecta) from Balh Valley (District Mandi in Himachal Pradesh), India. *Asian Journal of Advanced Basic Science* 2 (3): 66–70.
- Kunte K (2000) India—a lifescape: butterflies of Peninsular India. University Press/Indian Academy of Science, Hyderabad/Bangalore, 254 pp.
- Kunte K (2001) Butterfly diversity of Pune city along the human impact gradient. *Journal of Ecological Society* 13–14: 40–45.
- Lawton JH, Bignell DE, Bolton B, Bloemers GF, Eggleton P, Hammond PM, Hodda M, Holt RD, Larsen TB, Mawdsley NA, Stork NE (1998) Biodiversity inventories, indicator taxa and effects of habitat modification in tropical forest. *Nature* 391 (6662): 72–76. <https://doi.org/10.1038/34166>
- Lewington R (1999) How to identify butterflies. Harper Collins, London, 159 pp.
- Lintott PR, Bunnefeld N, Fuentes-Montemayor E, Minderman F,

- Blackmore LM, Goulson D, Kirsty JP (2014) Moth species richness, abundance and diversity in fragmented urban woodlands: implications for conservation and management strategies. *Biodiversity and Conservation* 23 (11): 2875–2901. <https://doi.org/10.1007/s10531-014-0753-z>
- Majumder J, Lodh R, Agarwala BK (2012) Variation in butterfly diversity and unique species richness along different habitats in Trishna Wildlife Sanctuary, Tripura, northeast India. *Check List* 8 (3): 432–436. <https://doi.org/10.15560/8.3.432>
- McKinney ML (2002) Urbanization, biodiversity, and conservation: the impacts of urbanization on native species are poorly studied, but educating a highly urbanized human population about these impacts can greatly improve species conservation in all ecosystem. *BioScience* 52 (10): 883–890. [https://doi.org/10.1641/0006-3568\(2002\)052\[0883:UBAC\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2002)052[0883:UBAC]2.0.CO;2)
- Mukherjee S, Aditya G, Basu P, Saha GK (2016) Butterfly diversity in Kolkata metropolis: a synoptic checklist. *Check List* 12 (2): 1858. <http://doi.org/10.15560/12.2.1858>
- Mukherjee S, Banerjee S, Saha GK, Basu P, Aditya G (2015) Butterfly diversity in Kolkata, India: an appraisal for conservation management. *Journal of Asia-Pacific Biodiversity* 8 (3): 210–221. <https://doi.org/10.1016/j.japb.2015.08.001>
- Murphy DD, Wilcox BA (1986) Butterfly diversity in natural habitat fragments: A test of the validity of vertebrate-based management. In: Verner J, Morrison ML, Ralph CJ (Eds) *Wildlife 2000: modelling habitat relationships of terrestrial vertebrates*. University of Wisconsin Press, Madison, 287–292.
- Nair AV, Mitra P, Bandyopadhyay SA (2014) Studies on the diversity and abundance of butterfly (Lepidoptera: Rhopalocera) fauna in and around Sarojini Naidu College campus, Kolkata, West Bengal, India. *Journal of Entomology and Zoology Studies* 2 (4): 129–134.
- Parasharya B, Jani J (2007) *Butterflies of Gujarat*. Anand Agriculture University, Anand, 138 pp.
- Pollard E (1977) A method for assessing changes in the abundance of butterflies. *Biological Conservation* 12 (2): 115–134. [https://doi.org/10.1016/0006-3207\(77\)90065-9](https://doi.org/10.1016/0006-3207(77)90065-9)
- Pollard E (1991) Monitoring butterfly numbers. In: Goldsmith FB (Ed) *Monitoring for conservation and ecology*. Springer, Dordrecht, 87–111. [https://doi.org/10.1007/978-94-011-3086-8\\_6](https://doi.org/10.1007/978-94-011-3086-8_6)
- Posa RMC, Sodhi NS (2006) Effects of anthropogenic land use on forest birds and butterflies in Subic Bay, Philippines. *Biological Conservation* 129 (2): 256–270. <https://doi.org/10.1016/j.biocon.2005.10.041>
- Raju AS, Bhattacharya ATANU, Rao SP (2004) Nectar host plants of some butterfly species at Visakhapatnam. *Science and Culture* 70 (4–5): 187–190.
- Rusman R, Atmowidi T, Peggie D (2016) Butterflies (Lepidoptera: Papilionoidea) of Mount Sago, West Sumatra: diversity and flower preference. *HAYATI Journal of Biosciences* 23 (3): 132–137. <https://doi.org/10.1016/j.hjb.2016.12.001>
- Sarma K, Kumar A, Devi A, Mazumdar K, Krishna M, Mudoi P, Das N (2012) Diversity and habitat association of butterfly species in foothills of Itanagar, Arunachal Pradesh, India. *Cibtech Journal of Zoology* 1 (2): 67–77.
- Shobana G, Gunasekaran C, Lena M, Agnes DA, Sharmila BA (2012) Diversity and abundance of butterflies in Villupuram District, Tamil Nadu, South India. *International Journal of Recent Scientific Research* 3 (7): 637–639.
- Singh AP (2011) *Butterflies of India*. OM Books International, Noida, 183pp.
- Singh SK, Srivastava SP, Tandon P, Azad BS (2009) Faunal diversity during the rainy season in the reclaimed sodic land of Uttar Pradesh, India. *Journal of Environmental Biology* 30 (4): 551–556.
- Thakur MS, Bhardwaj S (2012) Study on diversity and host plants of butterflies in lower shivalik hills, Himachal Pradesh. *International Journal of Plant, Animal and Environmental Sciences* 2 (1): 33–39.
- Thangapandian M, Ganesh A, Ramaraj P, Selvakumar C, Janarthanan S (2014) Diversity and status of butterflies in the city of Chennai, Tamil Nadu. *Hexapoda (Insecta Indica)* 21 (1): 1–9.
- Thomas JA (2005) Monitoring change in the abundance and distribution of insects using butterflies and other indicator groups. *Philosophical Transactions of the Royal Society B: Biological Sciences* 360 (1454): 339–357. <https://doi.org/10.1098/rstb.2004.1585>
- Tiple AD (2012) Butterfly species diversity, relative abundance, and status in tropical forest research institute, Jabalpur, Madhya Pradesh, central India. *Journal of Threatened Taxa* 4 (7): 2713–2717. <https://doi.org/10.11609/JoTT.o2656.2713-7>
- Tiple AD, Khurad AM (2009) Butterfly species diversity, habitats, and seasonal distribution in and around Nagpur city, central India. *World Journal of Zoology* 4 (3): 153–162.
- Van Nouhuys S, Hanski I (2002) Colonization rates and distances of a host butterfly and two specific parasitoids in a fragmented landscape. *Journal of Animal Ecology* 71 (4): 639–50. <https://doi.org/10.1046/j.1365-2656.2002.00627.x>
- Wynter-Blyth MA (1957) *Butterflies of the Indian region*. Bombay Natural History Society, Bombay, 523 pp.