



E-ISSN: 2320-7078

P-ISSN: 2349-6800

[www.entomoljournal.com](http://www.entomoljournal.com)

JEZS 2023; 11(2): 105-114

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Received: 06-11-2022

Accepted: 10-12-2022

**Avtar Kaur Sidhu**High Altitude Regional Centre,  
Zoological Survey of India,  
Solan, Himachal Pradesh, India

## Lepidoptera of India: A review

**Avtar Kaur Sidhu**DOI: <https://doi.org/10.22271/j.ento.2023.v11.i2b.9162>

### Abstract

The order Lepidoptera is one of the largest insect order known for pest species among moths and bioindicators among butterflies. The latter also form a major portion of Wildlife (Protection Act, 1972) especially among the insects. The remarkable diversity of Lepidoptera has been compiled by Nieuwerkerken *et al.* 2011, Heppner, 2014 worldwide but our knowledge of Indian diversity of order Lepidoptera is very poor. The present paper is an attempt to review the diversity and distribution of Lepidoptera in India.

**Keywords:** Lepidoptera, diversity, distribution, status, endemism

### Introduction

The order Lepidoptera is one of the most recognized and popular insect order which includes butterflies and moths, and is amongst four most species diverse orders along with Coleoptera, Diptera and Hymenoptera. It is an endopterygote insect order sharing a common phylogeny with order Trichoptera to form super order Amphiesmenoptera wherein instead of males, the females are heterogametic; the adults have dense setae and particular venation pattern on wings, and the larvae have mouth structures and glands to make silk. Lepidopterans were last to arrive on evolutionary scene and have been thought to be evolved almost parallel to angiosperms around 160 million years ago. The term Lepidoptera was proposed by Linnaeus in 1735 which means "scaly-winged" insects and order is characterized by the presence of pigment-bearing scales dense broad scales on their wings. These scales are flattened, modified hairs that give butterflies and moths their beautiful and distinctive colors patterns.

Lepidoptera shows diverse and remarkable features which makes it distinct and highly specialized group among insect orders. The Lepidoptera reproduce sexually and are holometabolus. The life cycle of Lepidopterans pass through four life history stages i.e. egg, larva or caterpillar, pupa or chrysalis and imago or adult which remarkably not only differ in morphology but also in habits. The larvae and pupae of some species are bimorphic i.e. these exist in two morph groups or polymorphic i.e. They differ in colour and number of attributes within a single species. In adults these variations are more pronounced. These may be sexual (males bright coloured), seasonal, geographical or individual. Occurrence of hybrids has also been recorded in butterflies. These life-history stages have evolved various protective adaptations including evolution of morphological characters and changes in ecological life-cycle and behavior in order to protect themselves from enemies and the predators such as birds, bats, lizards, amphibians, spiders, dragon flies and others. Caterpillars form major portion of the diet of predators and parasitoids including Hymenoptera and Diptera. It is the most venerable stage of the life of Lepidoptera, so they adopt variety of mechanisms to protect them. Lepidoptera also show Batesian and Mullerian mimicry complexes to escape enemies.

### Status of Taxon

While moths and butterflies are loved for their beauty, they are reviled, sometimes, for destructive feeding habits of their caterpillars. About 7% of all life forms on Earth are members of the Order Lepidoptera. The Macrolepidoptera, containing the butterflies, skippers and moth families makes about 60% of the order. The classification of Lepidoptera is under constant revision but is currently divided into 139 families. The revised current status of Lepidoptera along with distribution is given below.

**Corresponding Author:****Avtar Kaur Sidhu**High Altitude Regional Centre,  
Zoological Survey of India,  
Solan, Himachal Pradesh, India

**a) Global Status**

The vast majority of Lepidoptera are to be found in the tropics but substantial diversity do exist on most continents. The diversity of Lepidoptera has been estimated by John Heppner in 1991 (as about 2, 55,000 species) based partly on actual counts from the literature, partly on the card indices in the Natural History Museum (London) and the National Museum of Natural History (Washington), and partly on estimates. By 1998 Heppner considered it certainly a conservative statement and likely that the figure “may be even higher”. Hammond (1992) summarized his 'conservative estimates' wherein the Lepidoptera constitute 3.2% of 12.5 millions species, i.e., 4,

00,000 species. It is believed that a near-half-million species estimate indeed appears likely on the basis of available knowledge. Nieuwerkerken *et al.* (2011) in a joint effort, wherein 62 scientists worked to estimate the diversity of Lepidoptera of the world, recorded Lepidoptera to be comprised of 04 suborders, 139 families, 15,578 genera and 1,57,424 species described so far. After consultation of some recent literature after 2011, the species reported by scientists have been added in the tables 1-3 below, though much seems still to be left. The numbers of taxon under each division given in the tables below are self-explanatory.

**Table 1:** World Lepidopteran Suborders (After Nieuwerkerken *et al.* 2011, Heppner, 2014)

No.	Suborder	Infra-orders	Super-families	Families	Genera	Species	Fossil Genera/species	Geographical Distribution (After Holloway <i>et al.</i> , 1992)
1.	Unassigned	-	-	05	16	22	16/22	-
2.	Zeugloptera	-	1	1	21	160	3/6	Temperate regions of both Hemispheres
2.	Aglossata	-	1	1	1	2	-	Eastern Australasia
4.	Heterobathmiina	-	1	1	1	3	-	Temperate South America
5.	Glossata	06	42	131	15539	157293	32/58	Various geographical regions of world
	Total	06	45	139	15,578	1,57,480	50/86	

**a) Indian Status**

India with its diverse environment and vegetation, which comprises of different ecosystems, is gifted with Lepidoptera fauna. The butterfly fauna of India, which comprises 1501 species, has been studied and compiled by various workers (de Niceville 1886-1890; Bingham, 1905-1907<sup>[4, 5]</sup>; Evans, 1932<sup>[8]</sup>; Wynter-Blyth, 1957<sup>[26]</sup>; Cantile, 1963; Varhsney, 1991, 2006; Gaonkar 1996; and Kehimkar, 2008)<sup>[17]</sup>, from time to time but the knowledge in moth fauna is still in scattered form. The main workers who compiled Indian moth fauna are Hampson (1892-1896)<sup>[10-13]</sup>, Meyrick (1905-1914) and Bell and Scott (1937)<sup>[3]</sup>. Some family lists and regional

lists do come on moth fauna but these are far from complete. The number of estimated moth species in India has been given by various workers as 15, 000. Ghosh *et al.* reported 12000 species of moths from India referable to 75 families. After scrutiny of literature it found the most tedious task was to know the exact number of moth species from India. The classification of Lepidoptera is also reframed and revised in recent times. The table-2 below shows the diversity of India Lepidoptera Fauna as per current classification being followed in Lepidoptera and the names of super families and families represented in Indian region are given, containing approximately 12,345 species.

**Table 2:** Status of Order Lepidoptera in World and India

Superfamilies/Families	No. of Species from World	No. of Species from India
<b>Neopseustoidea</b>		
Neopseustidae	14	3
<b>Hepialoidea</b>		
Palaeosetidae	9	1
Hepialidae	606	20
<b>Nepticuloidea</b>		
Nepticulidae	819	16
Opostegidae	192	4
<b>Adeloidea</b>		
Heliozelidae	123	10
Adelidae	294	20
Incurvariidae	51	1
<b>Simaethistoidea</b>		
Simaethistidae	4	2
<b>Tineoidea</b>		
Tineidae	2393	1113
Eriocottidae	80	1
Psychidae	1350	99
<b>Gracillarioidea</b>		
Bucculatricidae	297	2
Gracillariidae	1866	339
<b>Yponomeutoidea</b>		
Douglasiidae	29	1
Yponomeutidae	363	22
Plutellidae	150	25
Glyphipterygidae	535	61
Heliodinidae	69	53
Bedelliidae	16	1

Lyonetiidae	204	106
<b>Gelechioidea</b>		
Elachistidae	3201	15
Xyloryctidae	524	16
Scythrididae	669	19
Oecophoridae	3308	94
Lecithoceridae	1200	3
Coleophoridae	1386	14
Cosmopterygidae	1792	114
Gelechiidae	4700	410
Blastobasidae	377	17
<b>Zygaenoidea</b>		
Epipyropidae	32	1
Limacodidae	1672	137
Lacturidae	120	1
Zygaenidae	1036	155
<b>Cossoidea</b>		
Sesiidae	1397	55
Castniidae	113	18
Cossidae	971	47
Dudgeoneidae	57	1
<b>Tortricoidea</b>		
Tortricidae	10387	434
<b>Choreutoidea</b>		
Choreutidae	407	23
<b>Epermenioidea</b>		
Epermeniidae	126	9
<b>Alucitoidea</b>		
Alucitidae	216	15
<b>Pterophoroidea</b>		
Pterophoridae	1318	109
<b>Carposinoidea</b>		
Copromorphidae	43	1
Carposinidae	283	15
<b>Pyraloidea</b>		
Pyralidae	5921	1246
Crambidae	9655	400
<b>Thyridoidea</b>		
Thyrididae	940	67
<b>Lasiocampoidea</b>		
Lasiocampidae	1952	100
<b>Bombycoidea</b>		
Eupterotidae	339	46
Bombycidae	185	15
Saturniidae	2349	40
Brahmaeidae	65	2
Sphingidae	1463	192
<b>Calliduloidea</b>		
Callidulidae	49	10
<b>Hesperioidea</b>		
Hesperiidae	4113	341
<b>Papilionoidea</b>		
Papilionidae	570	108
Pieridae	1164	114
Lycaenidae	5201	540
Nymphalidae	6152	522
Riodinidae	1532	16
<b>Drepanoidea</b>		
Drepanidae	660	101
<b>Geometroidea</b>		
Epicopeidae	20	12
Uraniidae	686	61
Geometridae	23002	1701
<b>Noctuoidea</b>		
Notodontidae	3800	154
Noctuidae	11772	2153
Erebidae	24569	681
Total		Approximate 12345

## Distribution

The order Lepidoptera is among one of the most successful orders that survive and found in all terrestrial habitats in every continent except Antarctica. Though they are far more numerous and diversified in the tropics, some species survive at the limits of polar vegetation. There are many successful

species in nearly every environment, from arid deserts and high mountaintops to marshes and tropical rainforests. The Indoaustralian region is most diverse with around 47, 286 Lepidoptera species followed by Neotropical region with about 44,791 species as shown in table-3 below.

**Table 3:** Regional distribution of Lepidoptera species diversity (After Heppner, 1991)

	Palaeartic	Nearctic	Neotropical	Afrotropical	Indoaustralian
Species	22,465	11,532	44,791	20,491	47,286
Area (mio sq mi)	18,751	8,817	7,202	9,796	7,449
Species/area	1.2	1.3	6.3	2.1	6.3

Indian mainly comes under Indoaustralian region and partially Palaeartic region. India has one of the richest and most diverse Lepidoptera fauna of the world. The diversity of species depends on factors like climate and topography of the region. Indian is a vast country with different type of physical features and contrasting climate zones from deserts to wetlands and from sea level to cold high altitude alpine regions. Being cold blooded and food specific animals, the distribution of Lepidopterans varies greatly depending upon the climate and vegetation zones in different biogeographic areas of India. The Himalaya has three types of vegetation zones, Subtropical in lower foothills and warmer valleys; Temperate zone extending upto tree line and Alpine zone from treeline upward upto zone of permanent snow and ice at higher peaks. The diversity of Lepidoptera varies with changing vegetation zones. The altitude of 3000 m is critical for Lepidoptera fauna, as 80 percent of species above this altitude has Palaeartic affinity. The Eastern region of Himalaya is more tropical and the Lepidoptera fauna has affinity with the Oriental region. From Sikkim state 689 species of butterflies have been recorded. Some of the most beautiful butterflies found in this region are Veined Jay, Redbase Jezebel, Birdwings, Gorgons, Swordtails. The Western Himalaya has comparatively drier climate and the lower and middle regions with treeline much lower than eastern region. The lower ranges of western Himalaya receives more rains than higher ranges and there are certain high altitude rain shadow zones in these ranges which comes under category of trans Himalaya. The Lepidoptera fauna varies greatly depending upon altitude. From Western Himalaya (Uttarakhand) 223 species of butterflies, from Western Himalaya (Himachal Pradesh) 228 species of butterflies and 184 species of moths, from Chandigarh 51 species of butterflies and from Punjab 72 species of butterflies have been recorded. Trans- Himalaya of Ladakh region is represented by 107 species of butterflies. The beautiful butterflies present in Western Himalaya upto altitude of 3000 m are Peacocks, Blackveins, Windmills, Hedge blues, Beaks, Coppers. Among high altitude and trans Himalayan fauna are Apollos, green underwings, bath whites. The diversity of Lepidoptera fauna in Western Himalaya is much less than eastern side and in trans ranges even far less due to harsh climatic conditions. Gangetic plains and deserts of India support mainly cosmopolitan Lepidoptera species except a few which typically confined to desert areas like Small Orange Tip, Bright Babul Blue, Small Salmon Arab, White Arab.

Zoogeographically South India has Lepidoptera fauna that is Oriental in origin with a few Palaeartic species from high altitude areas of Western and Eastern Ghats besides some Palaeotropical and Afrotropical species. The east of Western

Ghats is peninsular India with elevated hilly plateau of medium height called Deccan. The Lepidoptera diversity is rich in south India with many endemic species due to varied rich vegetation which includes Montane Wet temperate forests, dry deciduous forests, moist deciduous to semi evergreen and evergreen forests, and coastal areas. From peninsular India and the Western Ghats 350 species and 331 species of butterflies have been recorded. From states of Karnataka, Kerala and Tamil Nadu 318, 320 and 319 species of butterflies respectively have been recorded. The beautiful butterflies occurring in these areas are, Malabar Banded Swallowtail, Malabar Raven, Southern Birdwing, Malabar Rose, Malabar Banded Peacock, Nilgiri Tiger. The Andaman and Nicobar Island contain richest tropical humid forests. It contains 236 species of butterflies, of which many are endemic. The northeast India extends northwards towards foothills of eastern Himalaya from northern fringe of plains of Bengal. Heavy rainfall and dense, humid evergreen and semi-evergreen forests are characteristic features of this region which supports highly rich and diverse Lepidoptera fauna. From Meghalaya 104 species of butterflies have been recorded. The beautiful fauna of this region includes Saturniid moths, Keser-e-Hind, Bhutan Glory, Dragontails, Lacewings, Popinjay, Lascars. A few cases of invasive species have also been reported in India. A Iyaenid species *Telicada nyseus* which is inhabitant of South India has invaded into Himalayan ranges upto 3000 m and successful established there. The *T. nyseus* life history stages have been reported to be carried along ornamental flowers from south to north India.

## Endemicity

The Endemicity and Biogeography are interrelated denoting the unique existence of a species in the ecological state with unique niche characteristics. Endemicity to Order Lepidoptera is still uncertain and the exact figure of the world species as well as Indian species cannot be given. It is especially true in case of moths, as so far there is no in depth and standard study of enumeration of endemic taxa. The numbers of genera and species to be handled in this group are very large. In moths, there are many genera and species which are known from their original locality only and gave the impression that they are endemic. But for their assessment thorough surveys are required. In moths taxonomic studies of many families has not been done so far. Varshney (1998) reported 100 genera and 1500 species of Lepidoptera endemic to India but the names of taxa are not given. Among butterflies, Mondal (1998) reported three species endemic to south India, one species *Princeps mayo* to Andamans and five to north-west India. Ackery and Vane-Wright (1984) reported 11 Papilionid species, *Idea malabarica* (Danainae), *Parantica nilgiriensis* (Danainae), *Atrophaneura pandiyana* (Papilionidae),

*Atrophaneura rhodifer* (Papilionidae), *Graphium epaminondas* (Papilionidae), *Papilio Buddha* (Papilionidae), *Papiliodravidarum* (Papilionidae), *Papilio liomedon* (Papilionidae), *Papilio mayo* (Papilionidae), *Parnassius maharaja* (Papilionidae) and *Troides minos* (Papilionidae) endemic to India. Khatri (1993) has recorded 170 species of butterflies endemic to Andamans, 109 species to Nicobars and 13 species to both Andamans and Nicobars, out of the total 236 species. Shubhalaxmi *et al.* (2011) reported 25 species of six moth families from Northern Western Ghats endemic to India. Lovalekar *et al.* (2011) recorded lycaenid butterfly *Spindasis abnormis* endemic to Western Ghats. In Kerala out of 334 species of butterflies, 37 are endemic to the region (Pandhy *et al.* 2012). The distributional range of butterflies of India has been studied and recorded from time to time. The scrutiny of literature shows that there are certain species which are totally endemic to India. Then there are certain adjacent distinct zoogeographical regions to which the butterfly fauna is restricted and these include parts of India. First one is Trans-Himalayan Region which lie immediately north of the Great Himalayan range. The Trans-Himalayan

range has the affinities with Tibet, Pamirs and Afganistan. The Northwest Himalaya which has affinities with the fauna in Pakistan and Afghanistan. The Deccan Plateau region lying in the rain shadow of the Western Ghats and the fauna on this plateau is closely related with that of Ceylon. The Indo-Burma region includes North-Eastern India south of Brahmaputra River. The fauna of this region share high affinities with that of Southeast Asia. The East India fauna has affinities with some parts of China, Nepal and Bhutan. There are about 355 species/subspecies of butterflies endemic to India and its adjacent zoogeographical region, of which 129 species/subspecies are confined only to India as given in table-5. Taking endemic moths under consideration, nothing can be said with certainty. There is a long list of moth species which are believed to be endemic within the Indian boundaries. But lack of complete records of the distribution and considering their wide distribution patterns, the endemicity of moths can be questioned. The scrutiny of literature shows that there are about 1400 species of moths endemic to India but the results are vague as the distribution of many species has not been studied.

**Table 5:** Butterfly Species/Subspecies Endemic to India

S. No.	Family	Species/Subspecies	Locality
1.	Hesperiidae	<i>Bibasis kanara</i>	South India.
2.	Hesperiidae	<i>Celaenorrhinus ambareesa</i>	South India, Madhya Pradesh, Bengal
3.	Hesperiidae	<i>Celaenorrhinus badia</i>	Assam
4.	Hesperiidae	<i>Celaenorrhinus plagifera</i>	Sikkim
5.	Hesperiidae	<i>Celaenorrhinus zea</i>	Assam
6.	Hesperiidae	<i>Gerosis bhagava andamanica</i>	South Andaman
7.	Hesperiidae	<i>Tagiades japedus ravina</i>	Andamans
8.	Hesperiidae	<i>Oriens concinna</i>	Servarayan Hills, Nilgiris, Palnis, Coorg
9.	Hesperiidae	<i>Caloris auroclita</i>	Sikkim, Assam.
10.	Hesperiidae	<i>Sovia hyrtacus</i>	South India
11.	Hesperiidae	<i>Sovia malta</i>	Manipur
12.	Hesperiidae	<i>Arnetta vindhiana</i>	South India – Central India
13.	Hesperiidae	<i>Quedara basiflava</i>	Nilgiri Hills
14.	Hesperiidae	<i>Salanoemia noemi</i>	North East India (Sikkim, Assam)
15.	Hesperiidae	<i>Halpe honorei</i>	South India
16.	Hesperiidae	<i>Halpe scissa</i>	Assam
17.	Hesperiidae	<i>Thoressa astigmata</i>	Nilgiris
18.	Hesperiidae	<i>Thoressa honorei</i>	South India
19.	Hesperiidae	<i>Thoressa sitala</i>	Calcutta
20.	Hesperiidae	<i>Thoressa sitala</i>	Calcutta
21.	Lycaenidae	<i>Curetis saronis saronissaronis</i>	Andamans
22.	Lycaenidae	<i>Curetis saronis nicobarica</i>	Central Nicobars
23.	Lycaenidae	<i>Curetis saronis kondula</i>	Great Nicobars, Little Nicobars
24.	Lycaenidae	<i>Euaspa mikamii</i>	North East India
25.	Lycaenidae	<i>Euaspa miyashitai</i>	North East India
26.	Lycaenidae	<i>Chrysozephyrus tytleri</i>	Manipur (Mt. Kabru)
27.	Lycaenidae	<i>Chrysozephyrus sandersi</i>	Sikkim
28.	Lycaenidae	<i>Amblypodia anita andamanica</i>	Andamans
29.	Lycaenidae	<i>Iraota timoleon</i>	South India
30.	Lycaenidae	<i>Hypolycaena erylus andamana</i>	Andamans
31.	Lycaenidae	<i>Rapala rosacea</i>	Sikkim, Assam
32.	Lycaenidae	<i>Loxura atymnus prabha</i>	South Andamans
33.	Lycaenidae	<i>Loxura atymnus nicobarica</i>	Nicobars
34.	Lycaenidae	<i>Tajuria sebonga</i>	Manipur
35.	Lycaenidae	<i>Charana cepheis</i>	Assam
36.	Lycaenidae	<i>Rachana jalindra tarpina</i>	Andamans
37.	Lycaenidae	<i>Arhopala centaurus coruscans</i>	Andamans
38.	Lycaenidae	<i>Arhopala allata suffusa</i>	Manipur
39.	Lycaenidae	<i>Arhopala alea</i>	South India
40.	Lycaenidae	<i>Arhopala selta constanceae</i>	Andamans
41.	Lycaenidae	<i>Arhopala alesia wimberleyi</i>	Andamans
42.	Lycaenidae	<i>Arhopala fulla andamanica</i>	Andamans

43.	Lycaenidae	<i>Arhopala zeta</i>	Andamans
44.	Lycaenidae	<i>Thaduka multicaudata kanara</i>	Kanara
45.	Lycaenidae	<i>Zinaspia distorta</i>	Sikkim.
46.	Lycaenidae	<i>Surendra vivarna latimargo</i>	Andamans
47.	Lycaenidae	<i>Horaga onyx rana</i>	Andamans, Nicobars
48.	Lycaenidae	<i>Horaga albimacula albimacula</i>	Andamans
49.	Lycaenidae	<i>Ahlbergia leechii</i>	North East India
50.	Lycaenidae	<i>Spindasis evansii</i>	Assam
51.	Lycaenidae	<i>Spindasis abnormis</i>	South India (Coonor, Coorg)
52.	Lycaenidae	<i>Heliophorus hybrida</i>	Sikkim.
53.	Lycaenidae	<i>Discolampa ethion airavati</i>	Nicobars
54.	Lycaenidae	<i>Jamides celeno kinkurka</i>	Nicobars
55.	Lycaenidae	<i>Jamides ferrari ferrari</i>	Nicobars
56.	Lycaenidae	<i>Jamides alecto kondulana</i>	Nicobars
57.	Lycaenidae	<i>Lycaenopsis minima</i>	Manipur
58.	Lycaenidae	<i>Celatoxia albidisca</i>	South India (hills)
59.	Papilionidae	<i>Parnassius maharaja</i>	Kashmir
60.	Papilionidae	<i>Parnassius delphius atkinsoni</i>	Kashmir
61.	Papilionidae	<i>Parnassius simo acconus</i>	Sikkim
62.	Papilionidae	<i>Graphium epaminondas</i>	Andamans
63.	Papilionidae	<i>Graphium agamemnon andamana</i>	Andamans
64.	Papilionidae	<i>Graphium agamemnon pulo</i>	Nicobars (southern)
65.	Papilionidae	<i>Papilio liomedon</i>	South India (Western Ghats)
66.	Papilionidae	<i>Papilio polytes nikobarus</i>	Nicobar Islands
67.	Papilionidae	<i>Papilio dravidarum</i>	Western Ghats
68.	Papilionidae	<i>Papilio mayo</i>	Andaman Islands
69.	Papilionidae	<i>Papilio buddha</i>	South India
70.	Papilionidae	<i>Atrophaneura rhodifer</i>	Andamans
71.	Papilionidae	<i>Atrophaneura pandiyana</i>	South India
72.	Papilionidae	<i>Atrophaneura hector</i>	Bengal, South Bihar, Orissa, South India
73.	Papilionidae	<i>Troides minos</i>	Western Ghats
74.	Pieridae	<i>Baltia sikkima</i>	Sikkim
75.	Pieridae	<i>Pieris ajaka</i>	Kashmir
76.	Pieridae	<i>Cepora nerissa lichenosa</i>	Andamans
77.	Pieridae	<i>Cepora nadina andamana</i>	Andamans
78.	Pieridae	<i>Ixias pyrene andamana</i>	Andamans, Nicobars
79.	Pieridae	<i>Appias wardii</i>	Western Ghats
80.	Pieridae	<i>Hebomoia glaucippe roepstorffi</i>	Andamans
81.	Pieridae	<i>Eurema andersoni evansi</i>	Andamans
82.	Pieridae	<i>Eurema blanda moorei</i>	Andamans, Nicobars
83.	Pieridae	<i>Gandaca harina andamana</i>	Andaman
84.	Pieridae	<i>Gandaca harina nicobarica</i>	Nicobar
85.	Pieridae	<i>Colias phicomone phila</i>	Kashmir
86.	Pieridae	<i>Colias dubia</i>	Sikkim
87.	Nymphalidae	<i>Parantica nilgiriensis</i>	Western Ghats, Nilgiri Hills
88.	Nymphalidae	<i>Parantica aglea melanoleuca</i>	Andamans, Nicobars
89.	Nymphalidae	<i>Euploea core scherzeri</i>	Nicobars
90.	Nymphalidae	<i>Euploea core andamanensis</i>	Andamans
91.	Nymphalidae	<i>Idea malabarica</i>	South India (Mysore, Travancore, Nilgiri Hills)
92.	Nymphalidae	<i>Idea agamarschanacadelli</i>	Andamans
93.	Nymphalidae	<i>Polyura athamasandamanicus</i>	Andaman Islands
94.	Nymphalidae	<i>Aemona peali</i>	Assam
95.	Nymphalidae	<i>Parantirrhoea marshalli</i>	South India (Travancore, Coorg)
96.	Nymphalidae	<i>Lethe europa tamuna</i>	Nicobars
97.	Nymphalidae	<i>Lethe satyavati</i>	Assam
98.	Nymphalidae	<i>Lethe nicetas</i>	Sikkim, Assam, Manipur
99.	Nymphalidae	<i>Elymnias caudata</i>	South India
100.	Nymphalidae	<i>Elymnias cottonis</i>	Andamans
101.	Nymphalidae	<i>Elymnias pealii</i>	Assam
102.	Nymphalidae	<i>Mycalesis igilia</i>	Coorg, Nilgiri-Wynaad, Mysore
103.	Nymphalidae	<i>Mycalesis visala andamana</i>	Andamans
104.	Nymphalidae	<i>Mycalesis oculus</i>	South India (south of Nilgiris)
105.	Nymphalidae	<i>Mycalesis manii</i>	Nicobars
106.	Nymphalidae	<i>Mycalesis radza</i>	Andamans
107.	Nymphalidae	<i>Heteropsis adolphei</i>	South India (Coorg, Nilgiris)
108.	Nymphalidae	<i>Zipaetis saitis</i>	South India.
109.	Nymphalidae	<i>Ypthima affectata</i>	Assam, Manipur
110.	Nymphalidae	<i>Ypthima davidsoni</i>	Assam

111.	Nymphalidae	<i>Ypthima cantlei</i>	Assam (Kangpokpi)
112.	Nymphalidae	<i>Ypthima chenu</i>	Coorg, South India
113.	Nymphalidae	<i>Ypthima ypthimoides</i>	South India
114.	Nymphalidae	<i>Ypthima striata</i>	South India (Nilgiri Hills).
115.	Nymphalidae	<i>Phalanta alcippe andamana</i>	Andamans
116.	Nymphalidae	<i>Phalanta alcippe fraterna</i>	Nicobars
117.	Nymphalidae	<i>Vindula erota pallida</i>	Andamans
118.	Nymphalidae	<i>Cirrochroa nicobarica</i>	Nicobars.
119.	Nymphalidae	<i>Cirrochroa tyche anjira</i>	Andamans
120.	Nymphalidae	<i>Cupha erymanthis andamanica</i>	Andaman Islands
121.	Nymphalidae	<i>Cupha erymanthis nicobarica</i>	Nicobars
122.	Nymphalidae	<i>Pantoporia sandaka ferrari</i>	Andamans
123.	Nymphalidae	<i>Neptis hylas andamana</i>	Andamans
124.	Nymphalidae	<i>Athyma rufula</i>	Andamans
125.	Nymphalidae	<i>Euthalia acontheacontius</i>	Andamans
126.	Nymphalidae	<i>Cyrestis tabula</i>	Nicobars
127.	Nymphalidae	<i>Laringa horsfieldii andamanensis</i>	Andamans
128.	Nymphalidae	<i>Herona marathus andamana</i>	Andamans
129.	Riodinidae	<i>Abisara bifasciatabifasciata</i>	Andamans

### Threatened Taxa

Lepidoptera though in India is a species rich order, but the information on the threatened species is very less except butterflies. The Indian butterflies have been studied from time to time from British times and the random estimated information on their status has also been given. Major such works are by Evans (1932) <sup>[8]</sup> in his book 'The Identification of Indian Butterflies', Talbot (1947) <sup>[24]</sup> in 'Fauna of British India, including Ceylon and Burma, Butterflies', Wynter-Blyth (1957) <sup>[26]</sup> in 'Butterflies of Indian Region', Mani (1986) <sup>[18]</sup> in his book 'Butterflies of Himalaya', Kehimkar (2008) <sup>[17]</sup> in 'Book on Indian Butterflies', who besides providing information on the butterfly fauna of India, also gave status of all the taxa listed. The butterflies considered endangered in

India were given legislation protection by including them in Wildlife (Protection) Act, 1972, which came into force on 02.10.1980. These are included in revised lists of schedules. Varshney (1986) in "Threatened species of the Indian region" reported 363 rare and 144 very rare species and subspecies of Indian butterflies. He also included large Saturniid moths like Atlas and Moon moths in his list. Gupta and Mondal (2005) <sup>[9]</sup> in 'Red Data Book' on Indian butterflies published by Zoological Survey of India gave detailed information on Schedule-I species of Wildlife (Protection) Act, 1972. The butterflies species included in different schedules of Wildlife (Protection) Act, 1972 are summarized below. At present no moth species are included in schedules.

**Table 7:** Butterfly species included in various Schedules of Wildlife (Protection), Act, 1972 of India

WLPA, 1972	Papilionidae	Pieridae	Lycaenidae	Nymphalidae	Hesperiidae	Butterfly species/subspecies
Schedule-I	14 Species	6 Species	47 Species	61 Species	nil	128
Schedule-II	21 Species	21 species	114 species	145 species	3 species	304
Schedule-III	nil	nil	nil	nil	nil	
Schedule-IV	nil	4 species	1 species	5 species	9 species	19
Total	35	31	162	211	12	451

At International level legislation also Indian butterfly fauna have been given protection. Collins and Morris (1985) published the IUCN red data book exclusively on the Swallowtail butterflies of the world and included some Indian butterflies in it. IUCN in 2001 recommended all assessments from January, 2001 to use the latest adopted version and cite the year and version number. The IUCN Red List is constantly being updated and the version launched at the Rio+20 meeting in June 2012, assigns the species to one of

eight categories based on their risk of extinction. Species in the three categories of Critically Endangered, Endangered and Vulnerable are considered as 'threatened'. The category Near threatened implies to species likely to become endangered in the near future and Least concerned to species with lowest risk. The following Indian butterfly taxa are included in IUCN red list version 2013.2 assessed in 2014 under these categories.

**Table 7:** Butterflies included in IUCN red data list assessed in 2014 version 2013.2

Vulnerable	Near Threatened	Least Concern
<i>Euploea andamanensis</i>	<i>Idea malabarica</i>	<i>Amblypodia vivarna</i>
<i>Euploea scherzeri</i>	<i>Parantica nilgiriensis</i>	<i>Ancema ctesia</i>
<i>Graphium epaminondas</i>		<i>Apatura parisatis</i>
		<i>Arhopala bazaloides</i>
		<i>Artipe eryx</i>
		<i>Caleta caleta</i>
		<i>Cheritra freja</i>
		<i>Dodona eugenes</i>
		<i>Euploea core</i>
		<i>Eurema andersoni</i>

		<i>Eurema brigitta</i>
		<i>Euthalia dirtea</i>
		<i>Euthalia malaccana</i>
		<i>Jamides caerulea</i>
		<i>Junonia almana</i>
		<i>Junonia hierta</i>
		<i>Mycalesis heri</i>
		<i>Tirumala gautama</i>

Since India became a party to Convention on International Trade in Endangered Species (CITES) on 18th October 1976, it has provided data annually to the CITES secretariat on the trade of endangered species through its CITES Management Authority. The Indian lepidopteran species included in CITES are give below. These all are included in appendix II and are not necessarily threatened with extinction but may become so, unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with the survival of the species in the wild.

**Table 8:** Butterflies included in CITES

Species	Appendix
<i>Atrophaneura pandiyana</i> (Moore, 1881)	II
<i>Bhutanitis lidderdalii</i> Atkinson, 1873	II
<i>Teinopalpus imperialis</i> Hope, 1843	II
<i>Troides aeacus</i> (C. & R. Felder, 1860)	II
<i>Troides helena</i> (Linnaeus, 1758)	II
<i>Troides minos</i> (Cramer, 1779)	II

### Threats

Lepidoptera form an intricate part of the habitat. The larvae and adults directly depend on the plant species of particular habitat. Some species also show intricate relationships with ants and prey to many predators like spiders, amphibians, reptiles, birds and mammals. Many insect parasitoids depend on them. Thus they play a significant role in the food chain. All make them to value as ecological indicators because they are very sensitive to changes in habitat and climatic conditions. This is more vulnerable to these changes. In India for past several decades, the populations of species of Lepidoptera particularly butterflies have been facing tremendous threats due to loss of their habitat and excessive collection for commercial purposes.

The main threat to Lepidoptera is due to habitat destruction/loss, as they are directly plant dependent species. The forests have been/ are being cleared for agricultural development, Urbanization and industrialization, all leading to land conversion and posing biggest threat to Lepidoptera fauna. The overgrazing, fuel wood and fodder collection from protected areas are some of the other aspects which are responsible for the loss and degradation of the habitat of the Lepidoptera fauna. In agricultural fields the extensive use of pesticides and weedicides are used. These are very toxic and eradicate the useful life forms also along with the harmful individuals. Pesticides devastate the larval stages of the Lepidoptera and weedicides harm the larval host plant of them. The monoculture plantation has also ruined the habitat of the Lepidoptera especially in the high altitude regions of Himalaya. Most of the industries are also coming up in the Himalayan region and their pollution destroying the habitat by wiping out their nectar, larval and host plant. Collection of plants in large scale for the preparation of traditional medicines in high altitude areas also threat to the particular species. Overgrazing by the domestic animals/cattles has degraded the venerable habitats. Alpine meadows in the high

altitude are rich in various types of herbs and shrubs. One can easily see these alpine pastures grazed by domestic Yak in high altitude of Ladakh, Pangi Valley, dist. Chamba and Spiti Valley, dist. Lahaul & Spiti. The nomads usually take their cattle in the forests in protected area, which has devastated the understory of that area and with this particular species are also eradicated from that area. Tourist influx and throwing of non-degradable things by them in fragile ecosystems of trans-Himalaya is another important factor, posing threat to its environment and habitat. The upcoming building of dams in fragile ecosystems of lower ranges of Himalaya, have greatly affected its habitat and consequently direct bearing on Lepidoptera species dwelling in that area.

Climate change has changed the average temperature and rainfall pattern. With this long term changes have affected the flora and fauna. The cyclones and cloud burst in the recent years have panic us. The temperature plays a pivotal role in the biodiversity of the fauna. An IPCC (International panel on climate change) reported that with this global warming there will be an "increased risk of extinction to 20-30% of plant and animal species. With this there is a strong possibility butterflies will go extinct. The Convention on Biological diversity (CBD) has pointed out that invasion of alien species of insects is the cause for the dwindling of the population of the butterflies. Ronkay (2004) stated that butterflies and moths show a sensitive reaction to the change of abiotic factors. Thus, butterflies and moths can be considered as good indicator species in monitoring climate change. The Climate change has three main impacts on Lepidoptera species:

1. Change in abundance
2. Change in range, distribution or area
3. Changes in phenology (Woiwod, 1997).

It has been analyzed that with the upwards shifting range in altitude and latitude, will severely affect the population and survival of the Lepidoptera fauna. Increased migration is linked with climatic change. Thus, it has now been realized the fauna is much prone to extinction due to global warming also. With the melting of glaciers, there is upward shifting of the altitudinal range of alpine rare and endemic butterfly species and threatening there existence.

The butterflies and some beautiful moths particularly of families Saturniidae and Sphingidae are collected for trade. They are victims of collectors in all stages of their development- egg larvae, pupae and adult. The adult specimens are used in various decorative items such as ornaments, wall hangings, paperweight, greeting cards or show pieces and the immature stages are used in breeding to reared into undamaged adult. A single specimen of rare and beautiful butterfly is valued extraordinary and the lucrative trade of butterflies is prevalent all over the world. In India this trade is prevailing in Western Himalaya, Eastern Himalaya and Western Ghats. The smugglers from India and other countries mostly coming in high altitudes of the Himalayan region like Ladakh, Lahaul, Spiti, Sikkim and Meghalaya and persuade the local people with money to take them in the



localized butterflies rich regions. Several cases of smuggling of butterfly fauna have been recognized in the last decade where foreign smugglers have been caught with large number of butterflies and other insects. High altitude rare and endemic Indian species are sold in very high prices in the international market, posing a great threat to their vulnerable populations due to over collecting.

### Conservation

India is one of the 12 mega biodiversity countries of the world and one among the 194 signatories to the Convention on Biological Diversity (CBD) at Earth Summit in Rio de Janeiro in 1992. India has taken a number of policy initiatives towards conservation of nature, natural resources and biodiversity at international, national and regional levels. Some of the significant initiatives include the World Heritage Convention (1972), Convention on International Trade in Endangered Species of Flora and Fauna (CITES) 1975, Ramsar Convention on Wetlands (1975), FAO's International Undertaking on Plant Genetic Resources (1983), Convention on Biological Diversity (1992), UN Convention to Combat Desertification (1994), International Treaty on Plant Genetic Resources for Food and Agriculture (FAO 2001) among others. The most important legal system for protection of endangered animals in India is the Wildlife (Protection) Act, 1972. India ratified the World Heritage Convention in 1977 and since then five natural sites have been inscribed as areas of 'outstanding universal value'. These sites are: Kaziranga National Park, Keoladeo National Park, Manas National Park, Sundarbans National Park, and Nanda Devi National Park. India signed the Convention on Biological Diversity on 5th June 1992, ratified it on 18th February 1994 and brought it into force on 19th May 1994. This convention provides a framework for the sustainable management and conservation of India's natural resources.

The conservation of Lepidoptera in general and rare, endemic, threatened fauna in particular needs multidimensional steps. Though through various legislations at international level (IUCN, CITES, WWF) and at National level (WLPA, 1972), the threatened Indian butterfly fauna is protected but still it requires much strong steps to practically save it.

1. The butterflies and moths species are habitat and food plant specific, so the conservation of the habitat is of utmost importance. The habitat loss due to various human interferences should be resisted, and a balance should try to be created between conservation and development. Where the natural forests are severely depleted, measures such as planting forestry and food plants on which the Lepidoptera thrives should be initiated.
2. There is need to give attention on the priority basis to conserve the habitats of threatened, rare and endemic species such as the Apollo Himalayan butterflies. They are very precious due to their endemism and are found only in some small localized pockets. The alpine pastures need to be restored to conserve the fauna. The alpine meadows and diverse forest are helpful to reinstate the habitat of such species.
3. There are certain localized habitats which are rich in butterfly diversity and are popularly called as butterfly species rich spots. These habitats specifically need to be conserved.
4. More public awareness should be stressed for sake of better conservation and activities of smuggling should be checked through effective implementation of legislation.

Over collecting of rare and threatened species should be banned even for scientific studies to prevent the population of a given species from brining below the threshold of recovery.

5. The environmental friendly agricultural practices should be carried out. As lepidopterans depend on host and nectar plants during their larval and adult stages respectively, the lack of these sources has showed the degraded habitats and low species richness. The traditional agricultural practices can be way out to conserve the fauna. Various aspects of the conservation of biology are needed to protect the rare species.
6. The environmental friendly practices such as butterfly watching, butterfly gardening, butterfly parks, butterfly farming/ranching should be popularized to conserve the fauna in a natural way. There are some butterfly parks are there in India to protect the endangered and rare species. Likewise more parks can be opened and these will be helpful for the protection of the natural habitat, and is the best way to conserve the Lepidoptera fauna.
7. We each individual can protect and conserve the larval host plant and nectar plants of butterflies by protecting the small wild patch of our own area which will be helpful for saving the rare beautiful colour world of these creatures. In the words of Professor E.O. Wilson, "the loss of species is the folly our descendants are least likely to forgive us."

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