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Diversity Pattern of Butterfly Communities (Lepidoptera) at Mangrol Region of Kathiawar Peninsula, India

ASHOKKUMAR VAGHELA
ORCID No. 0000-0002-0473-9043
ashokvaghela2@gmail.com

POONAM BHADJA
VARSHA TRIVEDI
Department of Biosciences, Saurashtra University,
Rajkot - 360005, Gujarat, India.

Abstract - Butterflies (Lepidoptera) being potent pollinators and ecological indicators are examined in the present study. The diversity of butterfly communities of the Kathiawar Peninsula (*tropical and subtropical region*) was studied at Mangrol region of Kathiawar Peninsula. The pollard walk method was followed for observing butterflies. A total 348 specimens belonging to 27 species, 21 genera and 4 families were recorded in the study sites. Among the butterfly species maximum populations were recorded of Family Nymphalidae (55.56%) followed by Pieridae (22.22%), Papilionidae (14.81%) and Lycaenidae (7.41%). Evaluation of quantitative and qualitative community structure in relation to four study sites of the Butterfly species density (29.00) and relative density (26.96) were highest in sampling Site Mangrol where as species diversity index (H') were also highest (04.14).

Keywords - butterfly diversity, community, habitat type, Kathiawar Peninsula, tropical and sub-tropical region

INTRODUCTION

Biodiversity, especially in terms of ecologically sensitive species like butterflies (Lepidoptera: Rhopalocera) is important for estimating the general health as well as development of proper conservation plans for the entire ecosystem (Chowdhury and Soren, 2011). Butterflies are generally regarded as one of the best taxonomically studied groups of insects (Robbins and Opler, 1997), New et al. (1995) refers to them as the flagship taxa for invertebrate conservation and the plight of butterflies has been a focus of entomologists for over a century. Lepidoptera is a very large order that includes some of the most beautiful species and some of the most economically important pests in the class Insecta. Lepidoptera are beneficial as pollinators, silk producers, indicators of environmental quality and are appreciated for their aesthetic value. The holometabolous life history of butterflies reveals that Lepidoptera are exposed to a wide range of environmental influences, and they are highly sensitive to changes in temperature, humidity and light levels (Erhardt, 1985; Kremen, 1992; Sparrow et al., 1994; Chey et al., 1997). Increases in human population combined with advances in technology have directly subjected the ecosystems of the world to changes to which many Lepidoptera and other organisms cannot adapt (Boonvanno et al., 2000; Brattstrom et al., 2008). The butterfly fauna may be affected and endangered by many factors including a wide variety of human activities such as, use of pesticides, urbanization, intensive forestry, agriculture, and exotic species (New 1997; Wagner and Van Driesche 2010). Brattstrom et al. (2008) stated that butterfly behavior responds to weather conditions, while other studies, focus on single weather parameters, species or types of behavior (Douwes, 1976; Shreeve, 1984; Brown, 1997).

India is a paradise for butterflies, with nearly 1,501 out of 16.823 species recorded from all over the world (Wynter Blyth, 1957; Gaonkar 1996; Kunte, 2000). In Gujarat, total 78 species from Central Gujarat region, 59 species from the North Gujarat and 145 species from South Gujarat were recorded. There is no detailed information regarding butterflies of the Saurashtra coastal region, this is the first record of its kind from this area (Kathiawar Peninsula).

Kathiawar is a peninsula in western India, which is part of the Saurashtra region on the Arabian Sea coast of Gujarat state. It is bounded on the north by the great wetland of the Rann of Kutch, on the northwest by the Gulf of Kutch, on the west and south by the Arabian Sea, and on the southeast and east by the Gulf of Khambhat. The region Kathiawar experiences tropical and subtropical steppe climate type. This climate is a transitional climate falling between tropical desert and humid subtropical, with temperatures which are less extreme than the desert climate. The annual rainfall is between 300 and 850 mm and maximum temperatures during the summer can rise to 40°C. The study focused on diversity of butterflies (Lepidoptera), which are considered good indicators of terrestrial biodiversity and relatively easy to observe and recognize (Rodgers, 1986). This study also deals with how the community structure such as species richness and diversity changes with micro-spatial habitats and at the local scale, how it is influence by climate, as well as by habitat type. The present work therefore demands importance for a better understanding of health and integrity of the tropical and subtropical steppe of in Kathiawar peninsula, India.

OBJECTIVES OF THE STUDY

There is no detail information regarding butterflies of Saurashtra Coastal area. This is the first record of its kind from Coastal region of Kathiawar peninsula. The main aim of the study is (1) to inventory in natural and manmade areas and butterfly diversity around coastal town, (2) to check the influence of differences in ecology among the study site on the basis of their habitat and (3) variations of the species composition and population among study site.

MATERIALS AND METHODS

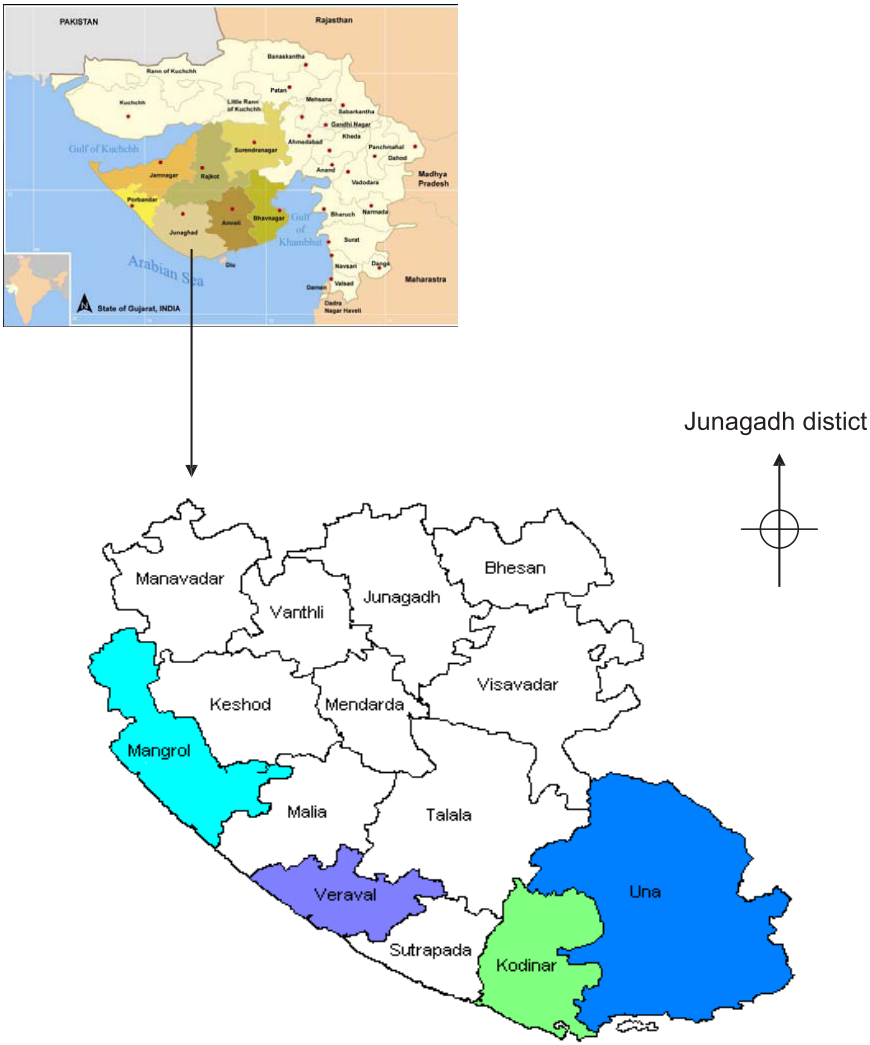

Fig.. 1. Map of Junagadh district showing study sites of butterflies

Study site

For the present study of butterfly diversity, Mangrol (25.20 N 76.31' E), Saurashtra region under Kathiawar peninsula was selected (Fig. 2). Total landscape area of Mangrol is 572.60 km^2 and annual rainfall are 450 to 550 mm. Climate of the study area relatively humid and cool. The study area is near the sea shore and surrounded by Coastal forest. There exists four clear seasons in the year, monsoon, postmonsoon, summer and winter which are typical in all part of the Gujarat region.

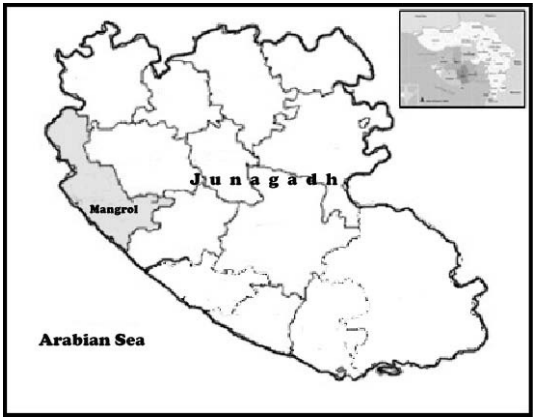

Fig. 2. Map showing the sampling location along the Kathiawar Peninsula for study of the butterfly diversity.

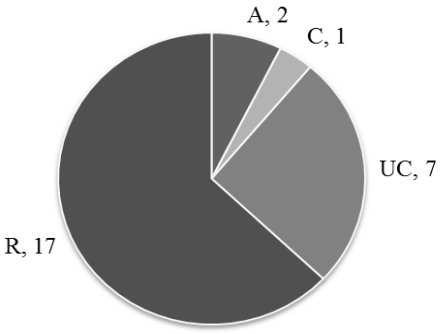

Fig. 3. Status of butterflies at the sampling location along the Kathiawar Peninsula

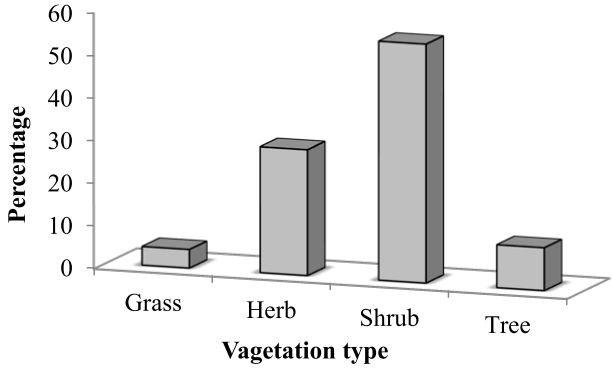

Fig. 4. Food/habitat type used by butterfly species along the sampling locations

Data Collection

The sampling location, Mangrol along Kathiawar peninsula was surveyed from July 2005 to June 2006 to assess the diversity of butterflies and each vegetation types where the butterfly species observed. Pollard walk method (Pollard, 1977; Pollard and Yates, 1993) was followed for observing butterflies, i.e., walking along the fixed paths while recording and counting the species. The observation width was limited to about 5 m. Butterflies were observed throughout the day from 08:00 h to 04:00 h under two visits in a month at each study sites for one complete year, observations were made under a total of 48 visits by random sampling technique. Butterflies were identified in the field using field guides by Wynter-Blyth (1957), Kunte (2000), Kehimkar (2008) and followed classification given by Gaonkar (1996).

Data Analysis

Data records from each visit were combined for assessments of species richness and relative abundance at each site. We performed an analysis of the total number of individuals, total species and individual number of butterflies in each family. The obtained data from each sampling site was calculated using the various diversity indices such

as Shannon-Wiener's diversity index (H') and Pielou's evenness (J') as per Odum (1971). The Shannon Index (H') was calculated by the formula

$$H' = -(PixlnPi)$$

where Pi is the fraction of the i^{th} species of total fauna.

Pielou's evenness (J') was calculated by the formula

$$J' = H'/lnS$$

where H' is the Shannon index as defined above, S is the number of species observed.

Species richness was calculated by the formula;

$$\frac{\text{Total No. of individuals of the species}}{\text{Total No. of occurrence}}$$

$$\text{Species density} = \frac{\text{Total No. of Individuals of the species}}{\text{Total No. of Visits}}$$

$$\text{Relative density} = \frac{\text{Total Density of the species} \times 100}{\text{Total no of occurrence.}}$$

Status of the butterfly species in the study area (i.e. common uncommon and rare) was calculated by using sightings of individual species. Wynter-Blyth (1957), Gay et al. (1992) and Kunte (2000) recorded food plants of various butterfly species. These plant species recorded from the study area were considered as food plants for butterflies.

RESULTS AND DISCUSSION

Twenty seven species of butterflies belonging to four families (Table 1) were recorded during the study. Nymphalidae were the richest family, comprising 15 registered species (53.74 %) followed by Pieridae (6 species; 29.02 %), Papilionidae (4 species; 13.79 %) and Lycaenidae

(2 species; 3.45 %) (Table 2). Nymphalidae family was most frequently observed compared to Family Lycaenidae which was observed less. A total of 348 butterflies of 27 species from sampling site Mangrol was observed during the study period. The overall population and comparison of butterfly species at the sampling site are illustrated in Table 1. The proportion of rare (R), common (C), uncommon (UC) and abundant (A) species did not appear significantly among the different habitats (Table 1). Butterfly species of Lycaenidae family such as *Castalius rosimon* and *Euchrysops cnejus* were found rare throughout the study period. Butterflies are being potential pollinating agents of their nectar plants as well as indicators of the health and quality of their host plants and the ecosystem as a whole, exploration of butterfly fauna thus becomes important in identifying and preserving critical wetland habitats under threat (Chowdhury and Soren, 2011). The occurrence of rare species may provide important information for conservation, but a more accurate and rapid assessment of the condition of the habitat may be obtained by monitoring a carefully selected group of locally common species (Boonvanno et al., 2000).

Table 1. Checklist of butterflies from Mangrol along the Kathiawar Peninsula (n = 12)

No.	English Name	Scientific Name	Status of Butterflies
Family - Papilionidae			
01.	Common Rose	*Pachliopta aristolochiae* (Fabricius 1775)	UC
02.	Common Mormon	*Papilio polytes* (Linnaeus 1758)	UC
03.	Lime Butterfly	*Papilio demolius* (Linnaeus 1758)	R
04.	Tailed Jay	*Graphium agamemnon* (Linnaeus 1758)	R
Family - Pieridae			
05.	Spotless Grass Yellow	*Eurema laeta* (Boisduval 1836)	A
06.	Common Gull	*Cepora nerissa* (Fabricius 1775)	R
07.	White Orange Tip	*Ixias Marianne* (Cramer 1779)	R
08.	Yellow Orange Tip	*Ixias pyrene* (Linnaeus 1764)	UC
09.	Small Orange Tip	*Colotis etrida* (Boisduval 1836)	R
10.	Mottled Emigrant	*Catopsilia pyranthe* (Linnaeus 1758)	R

Family - Lycaenidae			
11.	Common Pierrot	*Castalius rosimon* (Fabricius 1775)	R
12.	Gram Blue	*Euchrysops cnejus* (Fabricius 1798)	R
Family - Nymphalidae			
13.	Common Evening Brown	*Melanitis leda* (Linnaeus 1758)	R
14.	Common Fivering	*Ypthima baldus* (Fabricius 1775)	R
15.	Painted Lady	*Cynthia cardui* (Linnaeus 1758)	UC
16.	Lemon Pansy	*Junonia lemonias* (Linnaeus 1758)	R
17.	Peacock Pansy	*Junonia almana* (Linnaeus 1758)	R
18.	Blue Pansy	*Junonia Orithya* (Linnaeus 1758)	UC
29.	Twany Castor	*Acraea violae* (Fabricius 1793)	R
20.	Great Eggfly	*Hypolimnas bolina* (Linnaeus 1758)	R
21.	Danaid Eggfly * **	*Hypolimnas misippus* (Linnaeus 1758)	C
22.	Blue Tiger	*Tirumala limniace* (Cramer 1775)	UC
23.	Plain Tiger	*Danaus chrysippus* (Linnaeus 1758)	A
24.	Striped Tiger	*Danaus genutia* (Cramer 1779)	R
25.	Common Indian Crow****	*Euploea core* (Cramer 1780)	UC
26.	Joker	*Byblia ilithyia* (Drury 1773)	R
27.	Baronet	*Euthalia nais* (Forster 1771)	R

Abbreviations:
A – abundant, C- common, UC- uncommon, R- rare.
Asterik marks indicate Schedule category - * SCH I, ** SCH II, **** SCH IV. Annon (1972). The entire scientific names follow Kunte (2000).

Table 2. Individual number of recorded Butterflies from Mangrol Sampling site along the Kathiawar Peninsula

No.	Scientific Name	Mangrol	%
Family - Papilionidae		**48**	**13.79**
1.	*Pachliopta aristolochiae* Fabricius	16	4.60
2.	*Papilio polytes* Linnaeus	17	4.89
3.	*Papilio demolius* Linnaeus	06	1.72
4.	*Graphium agamemnon* Linnaeus	09	2.59

Family - Pieridae		**101**	**29.02**
5.	*Eurema laeta* Boisduval	51	14.66
6.	*Cepora nerissa* Fabricius	08	2.30
7.	*Ixias marianne* Cramer	08	2.30
8.	*Ixias pyrene* Linnaeus	20	5.75
9.	*Colotis etrida* Boisduval	03	0.86
10.	*Catopsilia pyranthe* Linnaeus	11	3.16
Family - Lycaenidae		**12**	**3.45**
11.	*Castalius rosimon* Fabricius	03	0.86
12.	*Euchrysops cnejus* Fabricius	09	2.59
Family - Nymphalidae		**187**	**53.74**
13.	*Melanitis leda* Linnaeus	06	1.72
14.	*Ypthima baldus* Fabricius	03	0.86
15.	*Cynthia cardui* Linnaeus	20	5.75
16.	*Junonia lemonias* Linnaeus	04	1.15
17.	*Junonia almana* Linnaeus	03	0.86
18.	*Junonia orithya* Linnaeus	22	6.32
19.	*Acraea violae* Fabricius	01	0.29
20.	*Hypolimnas bolina* Linnaeus	10	2.87
21.	*Hypolimnas misippus* Linnaeus	29	8.33
22.	*Tirumala limniace* Cramer	17	4.89
23.	*Danaus chrysippus* Linnaeus	51	14.66
24.	*Danaus genutia* Cramer	02	0.57
25.	*Euploea core* Cramer	16	4.60
26.	*Byblia ilithyia* Drury	02	0.57
27.	*Euthalia nais* Forster	01	0.29
	Total number of specimens	**348**	**100.00**

Table 3. Family-wise number of genus and species of butterflies

Sr. No.	Family	Number			
		Genus	%	Species	%
1.	Papilionidae	03	14.29	04	14.81
2.	Pieridae	05	23.81	06	22.22
3.	Lycaenidae	02	09.52	02	07.41
4.	Nymphalidae	11	52.38	15	55.56
	Total	**21**	**100**	**27**	**100**

Table 4. Butterfly species density (D), relative density (RD), Diversity index (H^*) and Evenness indices (E) of all sites

No. of Visits	Total no. of individuals	Species Density (D)	Relative Density (RD)	Diversity Index (H^*)	Evenness Indices (E)
12	348	29.00	26.96	4.14	2.89

The diversity of butterfly community in Mangrol sampling site, Kathiawar peninsula is presented in Table 4. Diversity indices were measure of way in which individuals in an ecological community are distributed among species. The measure of diversity was representing the number and availability of niches present in that environment. Quantitative and qualitative analysis include species density; relative density, species diversity (H'), and Evenness indices of butterfly are given in Table 4. The species density (D) is quite highest value of 29.00 at the sampling location. The results of diversity index showed that the butterflies were richly distributed at the Mangrol site where the vegetation was dense and abundant. Shannon wiener index (H') is the most widely used in community ecology. The Evenness component diversity followed by Pielon (1966), the Evenness observed 2.89 during the study period (Table 4). The reason for the increase in diversity might be due to the favorable tropical climate conditions, availability of more number of larval host plants and vegetation cover of herbs, shrubs and trees for nectar of butterflies.

The habitat preference of butterflies is often linked with the food source. The rich diversity of butterflies, especially the Nymphalids in Mangrol indicates a varied assemblage of floral species, particularly among the dense vegetation. The diversity and abundance of species is highly correlated with the availability of food plants in the surroundings (Kunte, 2000). Occurrence of the maximum number of species in the family Nymphalidae could be the result of high availability of food plants in the particular study area. Nymphalids butterflies feed on nineteen different food plants belonging to ten families, whereas Papilionids feed on ten food plant species belonging to six families (Boonvanno et al., 2000). Pierids feed on ten food plant species, belonging to seven families, whereas Lycaenids feed on two food plant belonging to one single family. The overall result of food resource reveals that maximum species of butterflies were feed on shrub plants (56.04 %), followed by herb (29.53%), tree (10.07%) and grass (4.36) (Fig. 4). The shrub and grass habitat has a high proportion of common butterfly species with a wide geographical distribution range (Vu, 2009). Plants of family Verbinaceae were maximum used as food by species of butterflies. A total of 22 plants were observed as food material during the study period. Food plants used by butterflies include *Zea mays* (Graminieae), *Sehima nervosum* (Graminieae), *Cenchrus cilioric* (Graminieae), *Sehima nervosum* (Graminieae), *Lantana camera* (Verbinaceae), *Duranta plumieri* (Verbinaceae), *Ipomea palmate* (Convolvulaceae), *Calotropis gigantia* (Asclepidaceae), *Cenchrus cilioric* (Graminieae), *Euphorbia hitra* (Euphorbiaceae), *Ricinus communis* (Euphorbiaceae), *Nerium indicum* (Apocynaceae), *Hibiscus rosasinensis* (Malvaceae), *Thevetia peruviana* (Apocynaceae), *Jasminum aureum* (Oleaceae), *Abutilon indicum* (Malvaceae), *Calotropis procera* (Asclepidaceae), *Tridex procumbens* (Compositae), *Nerium odoratum* (Apocynaceae), *Ficus religiosa* (Moraceae), *Lantana camera* (Verbinaceae) and *Duranta plumieri* (Verbinaceae).

CONCLUSIONS

Lepidoptera is being potent pollinators and ecological indicators. Diversity of butterfly communities in tropical and subtropical region was studied at Mangrol region of Kathiawar Peninsula. Total 348

specimens belonging to 27 species, 21 genera and 04 families were recorded in the study site. Among the butterfly species Maximum populations recorded of Family Nymphalidae (55.56 %) followed by Pieridae (22.22 %), Papilionidae (14.81 %) and Lycaenidae (7.41 %). Evaluation of quantitative and qualitative community structure in relation to four study sites of the Butterfly species density (29.00) and relative density (26.96) were highest in sampling Site Mangrol. The measures of species diversity play a central role in ecology and conservation biology, species diversity index (H') were also highest (04.14) at sampling Site Mangrol. It was reported that higher Shannon diversity index, in the range of 2.5-3.5, as a healthy condition for this coastline (Ajamal Khan et al., 2004).

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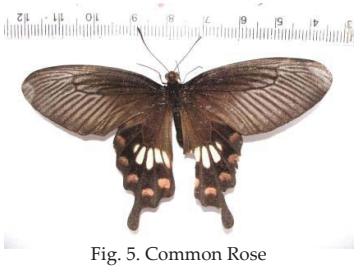

Fig. 5. Common Rose
Pachliopta aristolochiae Fabricius

Fig. 6. Lime Butterfly
Papilio demolius Linnaeus

Fig. 7. Common Mormon
Papilio polytes Linnaeus

Fig. 8. Tailed Jay
Graphium agamemnon Linnaeus

Fig. 9. Spotless Grass Yellow
Eurema laeta Boisduval

Fig. 10. White Orange Tip
Ixias marianne Cramer

Fig. 11. Common Gull
Cepora nerissa Fabricius

Fig. 12. Yellow Orange Tip
Ixias pyrene Linnaeus

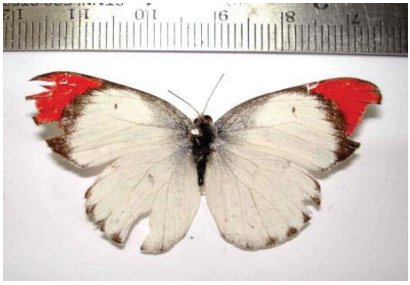

Fig. 13. Small Orange Tip
Colotis etrida Boisduval

Fig. 14. Common Evening Brown
Melanitis leda Linnaeus

Fig. 15. Common Emigrant
Catopsilia pomona Fabricius

Fig. 16. Common Five ring
Ypthima baldus Fabricius

Fig.17. Lemon Pansy
Junonia lemonias Linnaeus

Fig. 18. Peacock Pansy
Junonia almana Linnaeus

Fig. 19. Painted Lady
Cynthia cardui Linnaeus

Fig. 20. Blue Pansy
Junonia orithya Linnaeus

Fig. 21. Common Castor
Ariadne merione Cramer

Fig. 22. Great Eggfly
Hypolimnas bolina Linnaeus

Fig. 23. Twany Castor
Acraea violae Fabricius

Fig. 24. Danaid Eggfly
Hypolimnas misippus Linnaeus

Fig. 25. Blue Tiger
Tirumala limniace Cramer

Fig. 26. Striped Tiger
Danaus genutia Cramer

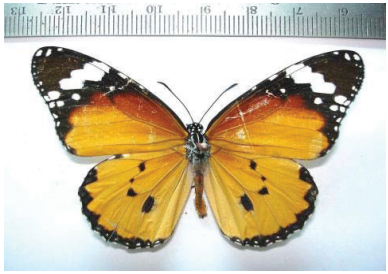

Fig. 27. Plain Tiger
Danaus chrysippus Linnaeus

Fig. 28. Common Indian Crow
Euploea core Cramer

Fig. 29. Joker
Byblia ilithyia Drury

Fig. 30. Baronet
Euthalia nais Forster