



Diversity of Butterflies (Lepidoptera: Rhopalocera) of Jhargram, Paschim and Purba Medinipur Districts, West Bengal, India

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Keywords: *butterflies, jhargram, paschim medinipur, purba medinipur, west bengal, india, lycaenidae, nymphalidae, urbanization, deforestation.*

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Diversity of Butterflies (Lepidoptera: Rhopalocera) of Jhargram, Paschim and Purba Medinipur Districts, West Bengal, India

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Abstract- Butterflies are one of the most attractive insects in the world, and they have been able to attract all kinds of peoples by their various features. This present documentation records the butterfly diversity of the three districts Jhargram, Paschim Medinipur, and Purba Medinipur, which formed the former Medinipur district. A total of 139 species belong to 94 genera and six families have been recorded. Among all families, Lycaenidae and Nymphalidae are the most abundant. Among the three districts, most species were found from Jhargram district. Fluffy Tit, Angled Pierrot and Common Lascar are the first time recorded from southern West Bengal. Rapid urbanization, deforestation, uncontrolled developmental works, and changing the character of Coastal zone is some of the threats to butterflies in these areas. So it was a great need to prepare a list of butterflies by which the past changes in the species diversity and number of butterflies in the future able to understand.

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I. INTRODUCTION

Insects has major contributors in the world biodiversity basically more than half of the world's species diversity and play an important role in maintaining the productivity and stability of the entire ecosystem [1, 2, 3, 4]. Butterflies are pollinators, food chain components as well as indicators of the health of the ecosystem, it is essential to identify them and prepare a list and protect their larval host plants and habitat [5, 6]. Butterflies help maintain the community structure of the flora of the tropical region [7]. Due to the decaying quality of butterflies' natural habitat and urbanization, the diversity and number of species are gradually declining [8, 9, 10, 11]. Butterfly research in India started in the nineteenth century with the assistance of various researchers [12]. Mega diversity country like India has also large depository in respect of butterflies which is about one fifth in the World biodiversity respect [13]. In India 1501 species of butterflies recoded [13, 14, 15] however some have mentioned 1318 species in the Indian subcontinent [16]. Many researchers explored the diversity of butterflies in various parts of India [17, 18,

19, 20, 21, 22]. A decent number of investigates on butterflies got from different places of West Bengal. The state West Bengal archived four hundred fifty-two species [23], although a researcher has likewise referenced 330 species [24]. Butterfly research in West Bengal is nearly contemporary with India, different analysts at various occasions propelling butterfly study of the southern division of this state [25, 26, 27, 28, 29, 30, 31]. Major research on butterflies found from Purba Medinipur among three districts of study area [32, 33, 34]. A unique field study from Paschim Medinipur district point outs that 82 species of butterflies present in the urban area of Midnapore [7]. In any case, no past exploration obtained from the immense locale outside the urban area of Paschim Medinipur and entire Jhargram District. Nonetheless, due to differing territory and rich forest area and being part of Chotanagpur plateau, there is a great chance of new species being encountered, that were not earlier found in South Bengal [35]. Documentation was comprehending the adjustments in the diversity and quantities of butterflies as anthropogenic movements expanded, and forest cover diminished. In the past, Jhargram, Paschim, and Purba Medinipur were part of undivided Medinipur district, so Purba Medinipur additionally incorporated for the survey alongside the other two districts.

II. MATERIAL AND METHODS

a) Study area

Jhargram, Paschim Medinipur and Purba Medinipur, located in the south-west of West Bengal, have been formed by breaking up the former Medinipur district at different times (Fig.1). Medinipur district first divided into Paschim and Purba Medinipur in 2002. Later in 2017, the Jhargram district was formed by separating from the Paschim Medinipur district. In other words, the three places of the study area were one district in the past. Headquarter of Jhargram lies at 21.4550° N latitude, and 86.9974° E longitude and the district covers 3037.64 km². Headquarter of Paschim Medinipur lies at 22.4257° N latitude, and 87.3199° E longitude and the district covers 6308 km². Headquarter of Purba Medinipur lies at 22.2858°N latitude, and 87.9189° E longitude and the district covers 4736 km². Jhargram district is deceit between the Kangsabati River

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in the north and the Subarnarekha River in the south. This district surrounded by Paschim Medinipur, Bankura, Purulia districts, and Odisha, Jharkhand states. Jhargram, Purba Medinipur, Bankura, Hoogly, Howrah districts, and Odisha states surrounded Paschim Medinipur district. Paschim Medinipur, Howrah districts, and Odisha state surrounded Purba Medinipur district. Purba Medinipur is bounded on the south by the Bay of Bengal, on the east by the river Hoogly and the northeast by the Rupnarayan River. Jhargram district is a part of Chotanagpur Plateau, which steadily slopes down on the way to the east. The altitude of the Kankrajhore area of this district is near about 300 meters. The average rainfall of this district is about 1400mm. This district is full of dry deciduous forests, which are the home of diverse life forms. Paschim Medinipur is one of the largest districts of the state, West Bengal. Western parts of this district are part of Chotanagpur Plateau and packed with lateritic soils. The landscape of this district modifies from dense, dry deciduous forests in the west to marshy wetlands in the east with an alluvial type of soil. The average rainfall of this district is about 2111mm. Purba Medinipur district is part of lower Gangetic and eastern coastal plains. This district has approximately 60 km coastline, which is about 27% of the shoreline of West Bengal. The average rainfall of this district is about 1700mm. The different natural habitats within the study area are also represented (Fig.2).

b) Sampling techniques and species identification

Diverse habitats of these districts have been surveyed from 2014 to 2019 through the Pollard's line transect method. Different information about butterflies collected through observation from 7 am to 11 am and from 2 pm to 6 pm. Transects were walked once a month in each district to follow Pollard Walk Method for documenting the butterflies [36, 37]. A slow 180-degree visual sweep carried out during walking. Along with that, Visual encounter assessment and Opportunistic survey, methods are also applied during the study period. Modifications of the line transect count used to find out butterfly richness and abundance [38]. In this method 10 permanent 300 meter lines transects were arrangement in each districts. Transects in every group was slowly crossed at a consistent speed during excellent weather period (no heavy rain or strong winds). Butterfly species recorded approximately a radius of five-meters from the observer covering either side, above, and front. All individuals were identified in the field using standard guides and field guide books [23, 39, 40]. Identification and classification of butterflies completed with these literature [41, 42, 43, 44, 45].

c) Data analysis

Data analyses were done through PAST software Version 3.02 [46].

i. Measurement of diversity

The kind of diversity used here is α -diversity, which is the diversity of species within a community or habitat. We calculated the diversity index by using this index [47].

- Diversity index = $H = -\sum P_i \ln P_i$, where $P_i = S / N$
- S = numeral of entities of one species
- N = sum total number of every individuals in the sample
- \ln = logarithm to base e

ii. Measurement of species richness

Species richness calculated through Margalef's index [48].

- Margalef's index = $(S - 1) / \ln N$
- S = sum number of species
- N = summation of individuals in the sample
- \ln = natural logarithm

iii. Measurement of evenness

For calculating the evenness of species, the Pielou's Evenness Index (e) used [49].

- $e = H / \ln S$
- H = Shannon – Wiener diversity index
- S = summation of species in the sample

iv. Dominance and Simpson Index

- $D = \sum (n_i/n)^2$ where n_i is number of entities of taxon i.
- Dominance = 1-Simpson index. Varies from 0 (all taxa are uniformly there) to 1 (one taxon dominates the community entirely).
- Simpson index 1-D. It calculates the 'evenness' of the community from 0 to 1. Dominance and Simpson indices frequently used interchangeably.

v. Species Accumulation Curve

Species accumulation curve is an approach by plotting the cumulative number of species collected against the sampling effort (sample unit). From the year 2014, the species accumulation curve for the three districts sampled individually increased from first to the last sampling though the number of new species included slowly.

vi. PCA (Principal Component Analysis)

Principal components analysis (PCA) finds hypothetical variables (components) accounting for as much as possible of the variance in multivariate data [50, 51]. Principal coordinates analysis (PCO) is a different ordination method, also known as Metric Multidimensional Scaling. Two variables were selected based on higher variance and the Eigen value scale. Density and frequency plotted as component 1, and component 2 respectively.

III. RESULTS

During the study period, 139 species of 94 genera belonging to 6 families from three districts have been recorded (Table 1). Lycaenidae family is dominant among all families, followed by Nymphalidae, Hesperidae, Pieridae, Papilionidae, and Riodinidae. 44 (31.65%) species of Lycaenidae family, 38 (27.33%) species of Nymphalidae, 28 (20.14%) species of Hesperidae, 17 (12.23%) species of Pieridae, 11 (7.91%) species of Papilionidae and only one species (0.71%) of Riodinidae have been found (Fig.3). Our study shows that 66 genera represent only one species, and 28 genera represent more than one species. *Junonia* is the largest genus with six species followed by *Papilio*, *Eurema*, *Graphium*, *Rapala*, *Spindasis*, *Chilades*, *Danaus*, and *Pelopidas*. Depending on the availability of butterflies, 66 species categorized as very common, 38 as common, 20 as less common, eight as rare, and seven species as very rare (Fig.4). The species accumulation curve is shown in fig.5. There are some Less Common (LC) species were Crimson Rose, Spot Swordtail, White Orange Tip, Small Salmon Arab, Three Spot Grass Yellow, Large Oakblue, Grass Jewel, Black Rajah, Common Sergeant, Water Snow Flat, Moore's Ace, Forest Hopper, Conjoined Swift, Variable Swift, and Plain Palm Dart, etc. The Rare (R) species of this district were Fivebar Swordtail, One Spot Grass Yellow, Indigo Flash, Malayan, Tawny Rajah, Tricolour Pied Flat, and Golden Angle, etc. The Very Rare (VR) species of this district were Spotless Grass Yellow, Angled Sunbeam, Redspot, Fluffy Tit, Angled Pierrot, Common Nawab, and Common Lascar. Of the three districts of the study area, most species were found in Jhargram (136 species), then in Paschim Medinipur (125 species) and least in Purba Medinipur (117 species) (Fig.6). Jhargram also had the highest number of exclusive species. Restricted species of Jhargram were Spot Swordtail, Fivebar Swordtail, Spotless Grass Yellow, Angled Sunbeam, Fluffy Tit, Indigo Flash, Angled Pierrot, Malayan, Common Nawab, Tawny Rajah, Common Lascar, and Golden Angle. Restricted species of Jhargram and Paschim Medinipur were Spot Swordtail, One Spot Grass Yellow, Indian Oakblue, Large Oakblue, Purple Leaf Blue, Common Hedge Blue, Baronet, and Tricolour Pied Flat. Restricted species of Purba Medinipur were Small Salmon Arab, Redspot, and White Tiger. Measurements of diversity-related indices are represented in table 2. Principal component analysis (PCA) of butterfly of these three districts, West Bengal based on Density and Frequency data (these two variables are taken based on higher Variance and Eigen value scale) presented in fig.7, 8 & 9. In both the cases, X-axis (component 1), i.e. Density and on the Y-axis (component 2), i.e. Frequencies are plotted, which show similarities between different species. So, there are six different families that are separated by principal

component analysis, and species are separated on PCA analysis based on these two variables. The families represented by the following colors - Papilionidae + cross red, Pieridae circle o, Lycaenidae triangle, Riodinidae square, Nymphalidae filled square, Hesperidae filled triangle. The PCA analysis showing family Nymphalidae widely distributed among the middle of the plot represented by filled square pinkish. PCA results indicate that two families occupy larger range, family Lycaenidae is forming its range inside the family Nymphalidae, and family Pieridae ranges between Nymphalidae and Lycaenidae. This overlapping distribution might be because of the same habitat preferences and availability of host plants. In figure 10 and 11, Normal Probability distribution of Density and Frequency are presented. Figure 12 showed Matrix plot with Number, Density, and Frequency of butterfly species. Correlations of Density and Frequency of butterfly species are showing in figure 13. Fig.14. correspond to Cluster analysis of three districts viz. Jhargram (1), Paschim Medinipur (2), Purba Medinipur (3) based on various diversity indices. Observed butterfly species photographed by Canon EOS 550 D, and represented in fig.15-23.

IV. DISCUSSIONS

Among the three districts of the study area, no butterfly documentation made earlier from Jhargram district. As there is no research work on butterfly in the past, it cannot compare with the present study. However, nearly similar findings showed in previous studies of neighboring Bankura and Purulia [31, 52]. The main reason is the similarity of landscape, weather, and flora's composition of these districts. Many rare species Obtained by Mukharjee and Mondal [31] in Bankura district such as Common Shot Silverline, Tailless Lineblue, Angled Sunbeam, Gaudy baron, Painted Lady, Black Rajah, Common Nawab, Tawny Rajah, Common Banded Peacock, Spotless Grass Yellow, Indian cabbage White, Golden Angle, Water Snow Flat, and Tricoloured Pied Flat also found in Jhargram district. Some other species found in the Bankura district are likely to be found in Jhargram; they are Scarce Shot Silverline, Bright Babul Blue, Double Branded Crow, Chocolate Albatross, and Common Small Flat, etc. Some of the rare species of Purulia [52], which also found in Jhargram viz. Indigo Flash, Common Red Flash, Black Rajah, Common Nawab and Fivebar Swordtail, etc. A research has been done from earlier in Paschim Medinipur district, based on this subject mainly the urban areas adjacent to Midnapore Sadar city and recorded 82 species [7]. At present, this study has found 125 species from the entire Paschim Medinipur District. The most research on butterfly documentation has been from the Purba Medinipur district [32, 33, 34]. The primary documentation finished from the Contai

(Kanthi) region, then the major research was done from the entire coastal area of this district and afterwards from the Haldia industrial zone. Overall 120 species recorded in these three studies from Purba Medinipur. The present status from our study reveals that about 117 species were found in entire Purba Medinipur District. Earlier in this district, Small Palm Bob (Very Rare), Giant Redeye (Very rare), Palm Redeye (Rare), Straight Swift (Common), Large branded Swift (Not Rare), Bevan's Swift (Rare) and Glassy Tiger (Very Rare) obtained by Payra et al. was not found in our present study. Small Cupid, Double Branded Crow, Bengal Spotted Flat, Small Branded Swift obtained by Pahari et al. was also not found in our study. In our current study, Redspot, Peacock Royal, Black Rajah, Gaudy Baron, Water Snow Flat, Paintbrush Swift, and Common Dartlet first time recorded from Purba Medinipur district. The documented result shows that the overall diversity of butterflies in the three districts of the study area is satisfactory. Some of these butterflies found from South Bengal for the first time. Fluffy Tit, Angled Pierrot, and Common Lascar butterflies first time recorded from South Bengal (24, 39). Redspot, a rare butterfly, was recorded second time from South Bengal which, was previously recorded only from Kolkata and North Bengal [53]. Some butterflies found from the coastal area of Purba Medinipur district, confined to that area only among the three districts. They are Redspot, Small Salmon Arab, and White Tiger. There are several butterflies in the elevated and forested environment of Jhargram district which are not found anywhere else in the three districts of the study area. They are Fivebar Swordtail, Spotless Grass Yellow, Angled Sunbeam, Fluffy Tit, Angled Pierrot, Common Lascar, Common Nawab, Tawny Rajah, Golden Angle, etc. The butterflies found in the coastal region of Purba Medinipur are likely to be found in the coastal region of South 24 Pargana, and the Butterflies found in Jhargram are likely to be found in Purulia, Bankura due to similar weather and geography. The butterfly diversity of a region is directly related to the larval host plants found in that region. Diversity of larval host plants of Jhargram district is more varied than the other two districts. Although most of the Paschim Medinipur similar to Jhargram district but presence of the less elevated regions, uncontrolled development work, and deforestation are the main reason of its less number of butterflies. However, the parts of Jhargram and Paschim Medinipur districts yet not illuminated in the light of such research for dense forests, inaccessibility, and political instability, which indicates the possibility of more new butterflies, will recorded in the future. Grass jewel, the smallest butterfly of India [54], found in good numbers in Jhargram and Paschim Medinipur but absent in Purba Medinipur district. Blue Mormon, the largest butterfly in South Bengal, is quite affordable in all the three districts. Small salmon Arab and White tiger are found only in the

coastal areas of Purba Medinipur. The number of Crimson Rose in the coastal region is higher than in other regions. The main reason for the good sighting of Gaudy Baron in the Shal forest area is the predominance of hemiparasitic taxon like *Dendrothe falcata* (Loranthaceae) as the larval host plant of the butterfly in this forest. This hemiparasitic plant also used as a larval host plant by Peacock royal, Broadtail Royal, Common Jezebel, etc. Different forms of several butterflies of the same species observed in all the three districts. They are Cyrus, Stichius, Romulus of Common Mormon and Dissimilis, Clytia of Common Mime, etc. In Ghatal Sub Division, Gram Blue, Pea Blue, Forget Me Not butterflies are predominant because of the abundance of leguminous vegetables in this region. Double-banded Judy, Bamboo Treebrown, and other shade lover butterflies can be seen commonly in shady places of forest or bush areas throughout the study region. All six species of Junonia found in India are also found in the study area. However, Yellow and Chocolate Pansy were more noticeable in the red soil forest area of Jhargram and Paschim Medinipur districts. Some butterflies of The Hesperiiidae family such as Golden angle, Water snow flat, Tricoloured pied flat were found more in the forest areas.

V. CONCLUSION

Our study will considered as baseline data for Jhargram and Paschim Medinipur districts, which will later help in finding out the changes of distribution, diversity of butterflies, and their possible causes in these two adjacent districts. It will also be easier to document new butterflies in these two districts using this inventory in future. In the case of the Purba Medinipur, the current study is more or less supporting the previous studies of that district. The addition of a few new butterflies that not documented from Jhargram and Paschim Medinipur districts previously indicates that there is a possibility of getting more new butterflies from these two districts in the future. At the same time, it is comprehensible that the diversity of butterflies depends on forest areas, which might be directly affected by future deforestation. Similarly, uncontrolled constructions in the coastal regions will be adversely affected bioindicators and pollinating agents like butterflies.

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Table 1: List of butterflies recorded from The District Jhargram, Paschim and Purba Medinipur districts, West Bengal, India

Family	Sl No.	Common name	Scientific name	Jhargram	Paschim Medinipur	Purba Medinipur	Status
Papilionidae	1	Common Mormon	<i>Papilio polytes</i> (Linnaeus, 1758)	+	+	+	VC
	2	Blue Mormon	<i>Papilio polymnestor</i> (Cramer, 1775)	+	+	+	C
	3	Lime Butterfly	<i>Papilio demoleus</i> (Linnaeus, 1758)	+	+	+	VC
	4	Common Mime	<i>Papilio clytia</i> (Linnaeus, 1758)	+	+	+	VC
	5	Common Banded Peacock	<i>Papilio crino</i> (Fabricius, 1793)	+	+	+	C
	6	Common Rose	<i>Pachliopta aristolochiae</i> (Fabricius, 1775)	+	+	+	VC
	7	Crimson Rose	<i>Pachliopta hector</i> (Linnaeus, 1758)	+	+	+	LC
	8	Common Jay	<i>Graphium doson</i> (C and R. Felder, 1864)	+	+	+	VC
	9	Tailed Jay	<i>Graphium agamemnon</i> (Linnaeus, 1758)	+	+	+	VC
	10	Spot Swordtail	<i>Graphium nomius</i> (Esper, 1793)	+	+		LC
	11	Fivebar Swordtail	<i>Graphium antiphates</i> (Cramer, 1775)	+			R
Pieridae	12	Psyche	<i>Leptosia nina</i> (Fabricius, 1793)	+	+	+	VC
	13	Common Gull	<i>Cepora nerissa</i> (Fabricius, 1775)	+	+	+	VC
	14	Yellow Orange Tip	<i>Ixias pyrene</i> (Linnaeus, 1764)	+	+	+	C
	15	White Orange Tip	<i>Ixias marianne</i> (Cramer, 1779)	+	+		LC
	16	Common Jezebel	<i>Delias eucharis</i> (Drury, 1773)	+	+	+	VC
	17	Striped Albatross	<i>Appias libythea</i> (Fabricius, 1775)	+	+	+	VC
	18	Indian cabbage White	<i>Pieris canidia</i> (Linnaeus, 1768)	+	+	+	C
	19	Common Wanderer	<i>Pareronia valeria</i> (Cramer, 1776)	+	+	+	VC
	20	Pioneer	<i>Belenois aurota</i> (Fabricius, 1793)	+	+	+	C
	21	Small Salmon Arab	<i>Colotis amata</i> (Fabricius, 1775)			+	LC
	22	Common Emigrant	<i>Catopsilia Pomona</i> (Fabricius, 1775)	+	+	+	VC
	23	Mottled Emigrant	<i>Catopsilia pyranthe</i> (Linnaeus, 1758)	+	+	+	VC
	24	Common Grass Yellow	<i>Eurema hecabe</i> (Linnaeus, 1758)	+	+	+	VC
	25	Three Spot Grass Yellow	<i>Eurema blanda</i> (Boisduval, 1836)	+	+	+	LC
	26	One Spot Grass Yellow	<i>Eurema andersoni</i> (Moore, 1886)	+	+		R
	27	Spotless Grass Yellow	<i>Eurema laeta</i> (Boisduval, 1836)	+			VR
	28	Small Grass Yellow	<i>Eurema brigitta</i> (Stoll, 1780)	+	+	+	C
	Lycaenidae	29	Indian Sunbeam	<i>Curetis thetis</i> (Hubner, 1819)	+	+	+
30		Angled Sunbeam	<i>Curetis acuta</i> (Moore, 1877)	+			VR
31		Falcate Oakblue	<i>Mahathala ameria</i> (Hewitson, 1862)	+	+	+	VC
32		Indian Oakblue	<i>Arthropala atrax</i> (Hewitson, 1862)	+	+		C
33		Large Oakblue	<i>Arthropala amantes</i> (Hewitson, 1862)	+	+		LC
34		Silverstreak Blue	<i>Iraota timoleon</i> (Stoll, 1790)	+	+	+	C
35		Common Guava Blue	<i>Virachola isocrates</i> (Fabricius,	+	+	+	C

		1793)				
	36	Purple Leaf Blue	<i>Amblypodia anita</i> (Hewitson, 1862)	+	+	C
	37	Redspot			+	VR
	38	Peacock Royal	<i>Tajuria cippus</i> (Fabricius, 1798)	+	+	C
	39	Broadtail Royal	<i>Creon cleobis</i> (Godart, 1824)	+	+	C
	40	Fluffy Tit	<i>Zeltus amasa</i> (Hewitson, 1865)	+		VR
	41	Yamfly	<i>Loxura atymnus</i> (Cramer, 1782)	+	+	C
	42	Monkey Puzzle	<i>Rathinda amor</i> (Fabricius, 1775)	+	+	VC
	43	Indian Red Flash	<i>Rapala iarbus</i> (Fabricius, 1787)	+	+	LC
	44	Slate Flash	<i>Rapala manea</i> (Hewitson, 1863)	+	+	VC
	45	Indigo Flash	<i>Rapala varuna</i> (Hewitson, 1863)	+		R
	46	Common Silverline	<i>Spindasis vulcanus</i> (Fabricius, 1775)	+	+	VC
	47	Common Shot Silverline	<i>Spindasis ictis</i> (Hewitson, 1865)	+	+	C
	48	Long- banded Silverline	<i>Spindasis lohita</i> (Horsfield, 1829)	+	+	LC
	49	Common Pierrot	<i>Castalius rosimon</i> (Fabricius, 1775)	+	+	VC
	50		<i>Tarucus</i> sp. (Moore, 1881)	+	+	VC
	51	Angled Pierrot	<i>Calida decidia</i> (Hewitson, 1876)	+		VR
	52	Zebra Blue	<i>Leptotes plinius</i> (Fabricius, 1793)	+	+	VC
	53	Apefly	<i>Spalgis epeus</i> (Westwood, 1851)	+	+	C
	54	Common Lineblue	<i>Prosotas nora</i> (Felder, 1860)	+	+	C
	55	Tailless Lineblue	<i>Prosotas dubiosa</i> (Semper, 1879)	+	+	VC
	56	Common Cerulean	<i>Jamides celeno</i> (Cramer, 1775)	+	+	VC
	57	Dark Cerulean	<i>Jamides bochus</i> (Stoll, 1782)	+	+	C
	58	Common Ciliate Blue	<i>Anthene emolus</i> (Godart, 1823)	+	+	C
	59	Pointed Ciliate Blue	<i>Anthene lycaenina</i> (C. Felder, 1868)	+	+	VC
	60	Forget Me Not	<i>Catochrysops strabo</i> (Fabricius, 1793)	+	+	VC
	61	Pea Blue	<i>Lampides boeticus</i> (Linnaeus, 1767)	+	+	VC
	62	Dark Grass Blue	<i>Zizeeria karsandra</i> (Moore, 1865)	+	+	C
	63	Pale Grass Blue	<i>Pseudozizeeria maha</i> (Kollar, 1848)	+	+	VC
	64	Lesser Grass Blue	<i>Zizina otis</i> (Fabricius, 1787)	+	+	C
	65	Tiny Grass Blue	<i>Zizula hylax</i> (Fabricius, 1775)	+	+	VC
	66	Grass Jewel	<i>Chilades trochylus</i> (Freyer, 1845)	+	+	LC
	67	Common Hedge Blue	<i>Acytolepis puspa</i> (Horsfield, 1828)	+	+	R
	68	Malayan	<i>Megisba malaya</i> (Horsfield, 1828)	+		R
	69	Quaker	<i>Neopithecops zalmora</i> (Butler, 1870)	+	+	VC
	70	Gram Blue	<i>Euchrysops cnejus</i> (Fabricius, 1798)	+	+	VC
	71	Plains Cupid	<i>Chilades pandava</i> (Horsfield, 1829)	+	+	VC
	72	Lime Blue	<i>Chilades lajus</i> (Cramer, 1782)	+	+	VC
Riodinidae	73	Double-banded Judy or Twospot Plum Judy	<i>Abisara bifasciata</i> (Moore, 1877)	+	+	C
Nymphalida	74	Blue Tiger	<i>Tirumala limniace</i> (Cramer, 1775)	+	+	VC
	75	Plain Tiger	<i>Danaus chrysippus</i> (Linnaeus,	+	+	VC

		1758)				
76	Striped Tiger	<i>Danaus genutia</i> (Cramer, 1779)	+	+	+	VC
77	White Tiger	<i>Danaus melanippus</i> (Cramer, 1777)			+	LC
78	Common Crow	<i>Euploea core</i> (Cramer, 1780)	+	+	+	VC
79	Brown King Crow	<i>Euploea klugii</i> (Moore, 1858)	+	+	+	C
80	Common Nawab	<i>Polyura athamas</i> (Drury, 1773)	+			VR
81	Black Rajah	<i>Charaxes solon</i> (Fabricius, 1793)	+	+	+	LC
82	Tawny Rajah	<i>Charaxes bernardus</i> (Fabricius, 1793)	+			R
83	Common Evening Brown	<i>Melanitis leda</i> (Linnaeus, 1758)	+	+	+	VC
84	Bamboo Treebrown	<i>Lethe europa</i> (Fabricius, 1787)	+	+	+	C
85	Common Palmfly	<i>Elymnias hypermnestra</i> (Linnaeus, 1763)	+	+	+	VC
86	Common Bushbrown	<i>Mycalesis perseus</i> (Fabricius, 1775)	+	+	+	VC
87	Dark Brand Bushbrown	<i>Mycalesis mineus</i> (Linnaeus, 1758)	+	+	+	C
88	Common Five Ring	<i>Ypthima baldus</i> (Fabricius, 1775)	+	+	+	VC
89	Common Four Ring	<i>Ypthima huebneri</i> (Kirby, 1871)	+	+	+	VC
90	Common Duffer	<i>Discophora sondaica</i> (Boisduval, 1836)	+	+	+	C
91	Tawny Coster	<i>Acraea violae</i> (Fabricius, 1775)	+	+	+	VC
92	Common Leopard	<i>Phalanta phalantha</i> (Drury, 1773)	+	+	+	VC
93	Commander	<i>Moduza procris</i> (Cramer, 1777)	+	+	+	VC
94	Angled Castor	<i>Ariadne ariadne</i> (Linnaeus, 1764)	+	+	+	VC
95	Common Castor	<i>Ariadne merione</i> (Cramer, 1777)	+	+	+	VC
96	Common Sailer	<i>Neptis hylas</i> (Linnaeus, 1758)	+	+	+	C
97	Chestnut - streaked Sailer	<i>Neptis jumbah</i> (Moore, 1857)	+	+	+	VC
98	Common Sergeant	<i>Athyma perius</i> (Linnaeus, 1758)	+	+		LC
99	Common Lascar	<i>Pantoporia hordonia</i> (Stoll, 1790)	+			VR
100	Common Barron	<i>Euthalia aconthea</i> (Hewitson, 1874)	+	+	+	VC
101	Gaudy Barron	<i>Euthalia lubentina</i> (Cramer, 1777)	+	+	+	LC
102	Baronet	<i>Symphaedra nais</i> (Forster, 1771)	+	+		VC
103	Painted Lady	<i>Vanessa cardui</i> (Linnaeus, 1758)	+	+	+	C
104	Blue Pansy	<i>Junonia orithya</i> (Linnaeus, 1758)	+	+	+	VC
105	Yellow Pansy	<i>Junonia hierta</i> (Fabricius, 1798)	+	+	+	C
106	Chocolate Pansy	<i>Junonia iphtia</i> (Cramer, 1779)	+	+	+	C
107	Lemon Pansy	<i>Junonia lemonias</i> (Linnaeus, 1758)	+	+	+	VC
108	Grey Pansy	<i>Junonia atlites</i> (Linnaeus, 1763)	+	+	+	VC
109	Peacock Pansy	<i>Junonia almana</i> (Linnaeus, 1758)	+	+	+	VC
110	Great Eggfly	<i>Hypolimnas bolina</i> (Linnaeus, 1758)	+	+	+	VC
111	Danaid Eggfly	<i>Hypolimnas misippus</i> (Linnaeus,	+	+	+	VC



		1764)				
112	Brown Awl	<i>Badamia exclamationis</i> (Fabricius, 1775)	+	+	+	C
113	Common Banded Awl	<i>Hasora chromas</i> (Cramer, 1780)	+	+	+	C
114	Common Snow Flat	<i>Tagiades japedus</i> (Stoll, 1782)	+	+	+	VC
115	Water Snow Flat	<i>Tagiades litigiosa</i> (Moeschler, 1878)	+	+	+	LC
116	Tricolour Pied Flat	<i>Coladenia indrani</i> (Moore, 1866)	+	+		R
117	Golden Angle	<i>Caprona ransonnetii</i> (Felder, 1868)	+			R
118	Indian Skipper	<i>Spialia galba</i> (Fabricius, 1793)	+	+	+	C
119	Bush Hopper	<i>Ampitta dioscorides</i> (Fabricius, 1793)	+	+	+	VC
120	Moore's Ace	<i>Halpe porus</i> (Mabille, 1876)	+	+	+	LC
121	Forest Hopper	<i>Astictopterus jama</i> (Felder and Felder, 1860)	+	+	+	LC
122	Chestnut Bob	<i>Iambrix salsala</i> (Moore, 1865)	+	+	+	VC
123	Indian Palm Bob	<i>Suastus gremius</i> (Fabricius, 1798)	+	+	+	VC
124	Grass Demon	<i>Udaspes folus</i> (Cramer, 1775)	+	+	+	VC
125	Tree Flitter	<i>Hyarotis adrastus</i> (Cramer, 1780)	+	+	+	VC
126	Banana Redeye or Banana Skipper	<i>Erionota torus</i> (Evans, 1941)	+	+	+	C
127	Common Red Eye	<i>Matapa aria</i> (Moore, 1865)	+	+	+	VC
128	Ceylon Swift	<i>Parnara bada</i> (Moore, 1878)	+	+	+	VC
129	Evan's Swift	<i>Parnara ganga</i> (Evans, 1937)	+	+	+	LC
130	Rice Swift	<i>Borbo cinnara</i> (Wallace, 1866)	+	+	+	C
131	Obscure Branded Swift	<i>Pelopidas agna</i> (Moore, 1865)	+	+	+	VC
132	Conjoined Swift	<i>Pelopidas conjuncta</i> (Herrich-Schaeffer, 1869)	+	+	+	LC
133	Variable Swift	<i>Pelopidas mathias</i> (Fabricius, 1798)	+	+	+	LC
134	Paintbush Swift	<i>Baoris farr</i> (Moore, 1878)	+	+	+	C
135	Common Grass Dart	<i>Taractrocera maevius</i> (Fabricius, 1793)	+	+	+	C
136	Common Dartlet	<i>Oriens gola</i> (Moore, 1877)	+	+	+	VC
137	Common or Pale Palm Dart	<i>Telicota colon</i> (Fabricius, 1775)	+	+	+	C
138	Dark Palm Dart	<i>Telicota bambusae</i> (Moore, 1778)	+	+	+	VC
139	Plain Palm Dart	<i>Cephrenes acalle</i> (Hopffer, 1874)	+	+	+	LC

[VC- Very Common, C- Common, LC- Less Common, R- Rare, VR- Very Rare]

Table 2: Diversity Indices
(Through PAST software Version 3.02)

Diversity Indices	Jhargram	Paschim Medinipur	Purba Medinipur
Taxa_S	136	125	117
Simpson_1-D	0.9918	0.9915	0.9908
Dominance_D	0.008183	0.008523	0.009192
Shannon_H	4.847	4.795	4.719
Evenness_e^H/S	0.9368	0.9668	0.9579
Margalef	15.02	13.83	13.03
Fisher_alpha	23.27	21.13	19.75

[Based on Diversity, Frequency and Numbers]

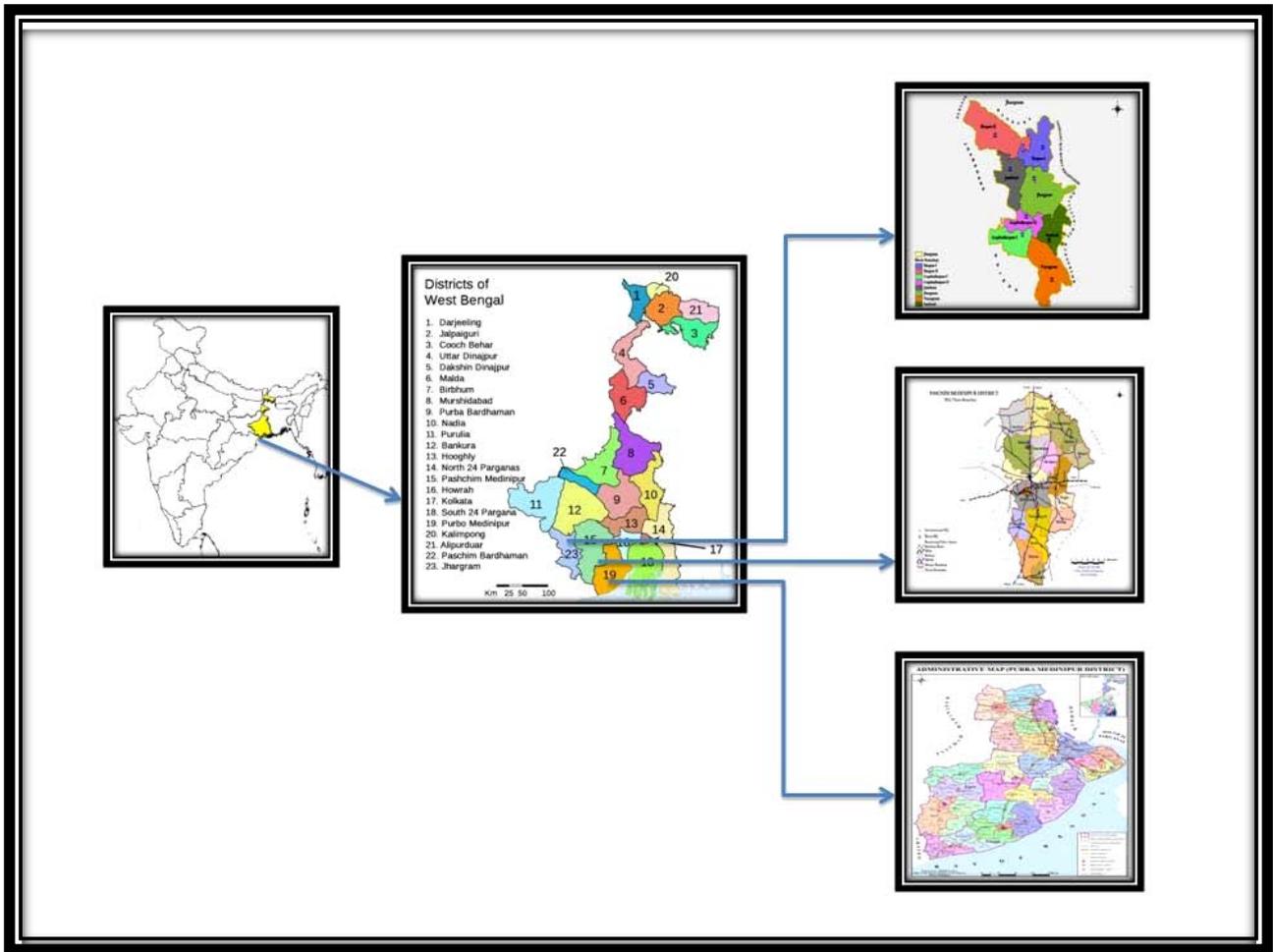


Figure 1: Study Area (A: West Bengal in India, B: West Bengal, C: Jhargram district, D: Paschim Medinipur district, E: Purba Medinipur district)



Figure 2: Habitats of Butterflies. A –H) Different habitats of district Jhargram. I –L) Different habitats of district Paschim Medinipur. M –P) Different habitats of district Purba Medinipur

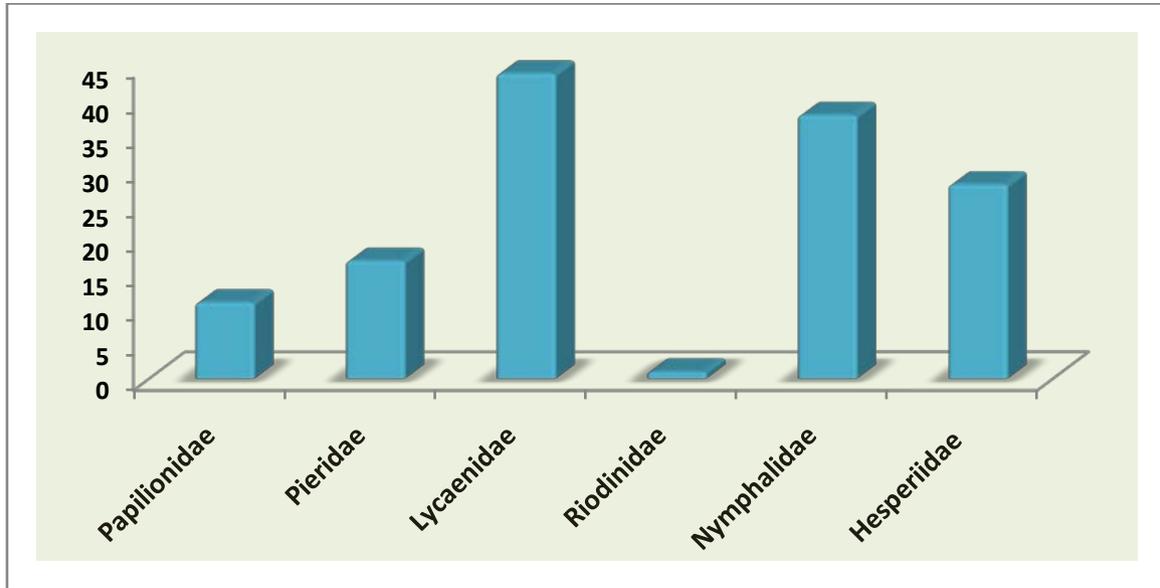


Figure 3: Number wise graphical representation of butterfly species

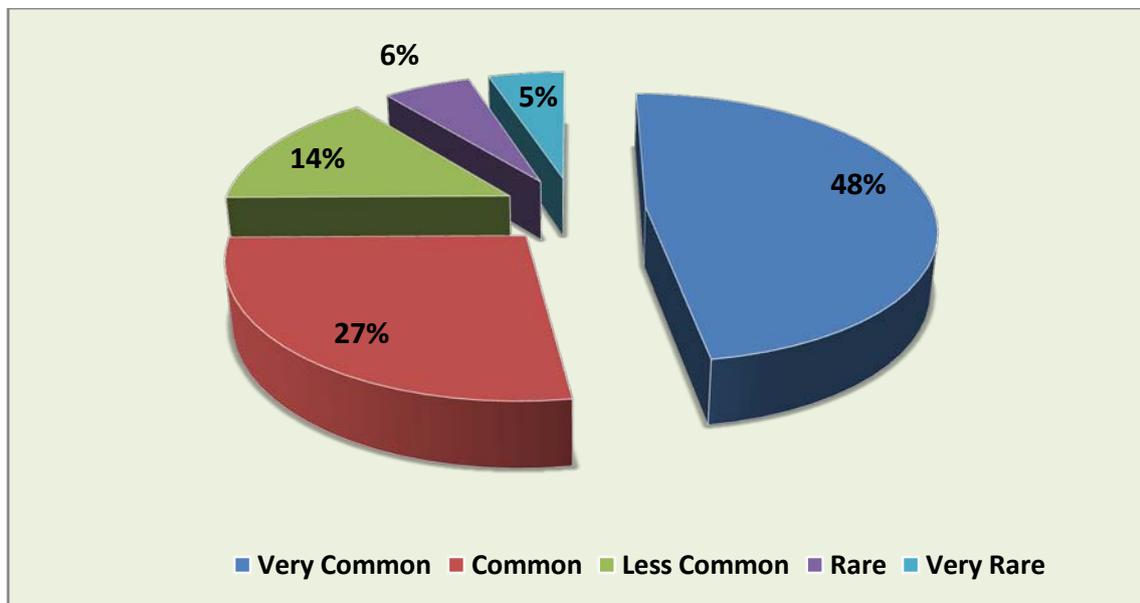


Figure 4: Status wise graphical representation of butterfly species

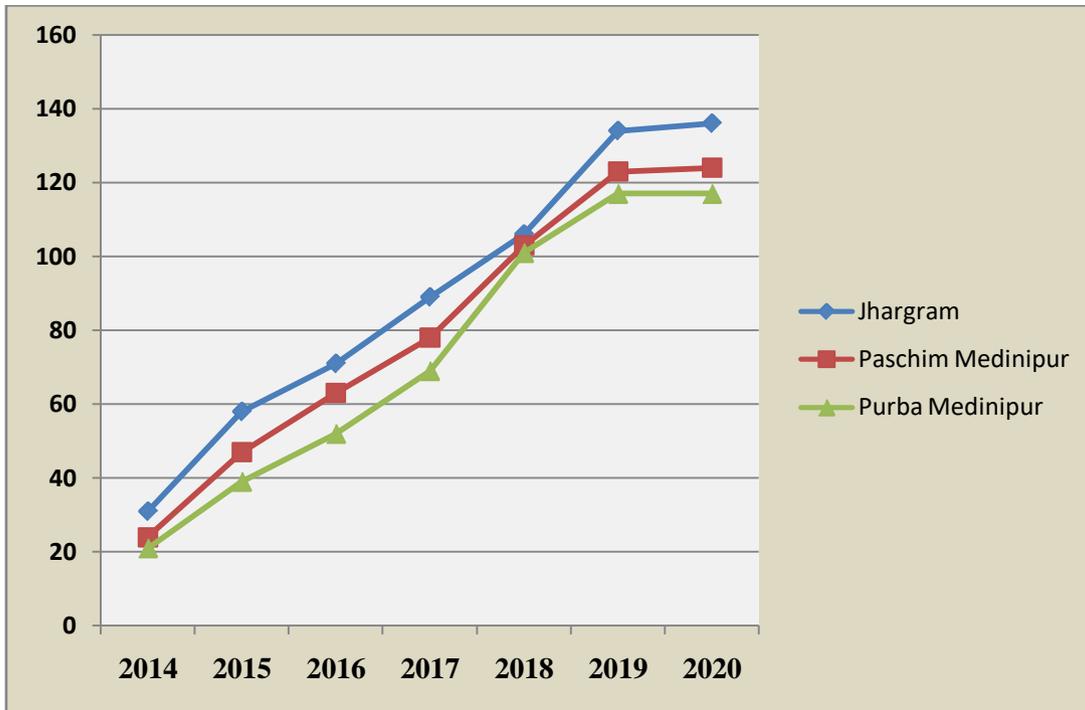


Figure 5: Species Accumulation Curve

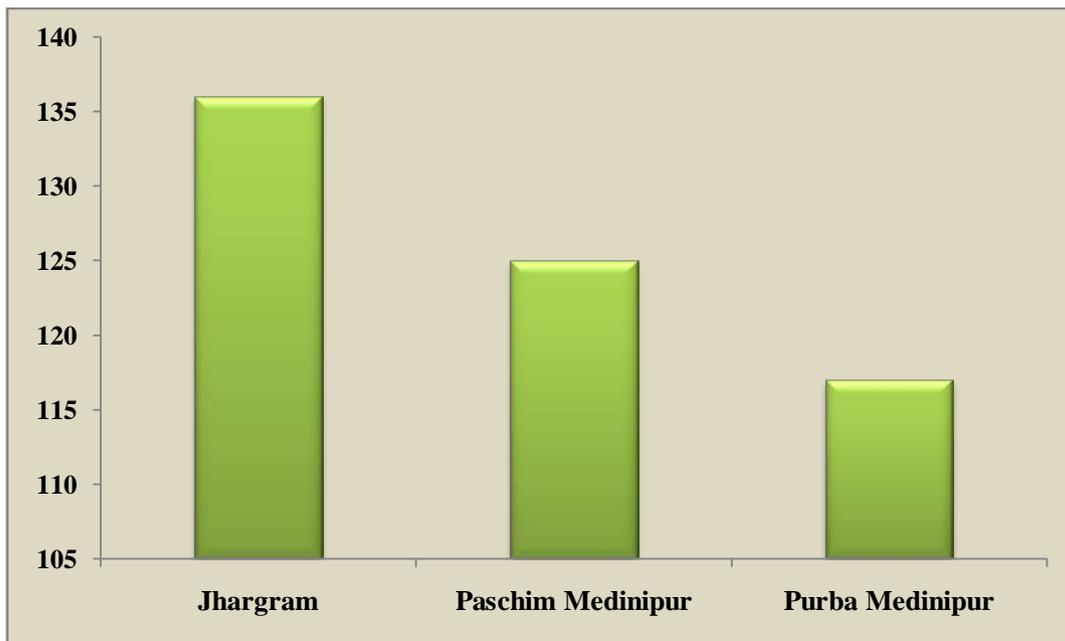


Figure 6: District wise graphical representation of butterfly species

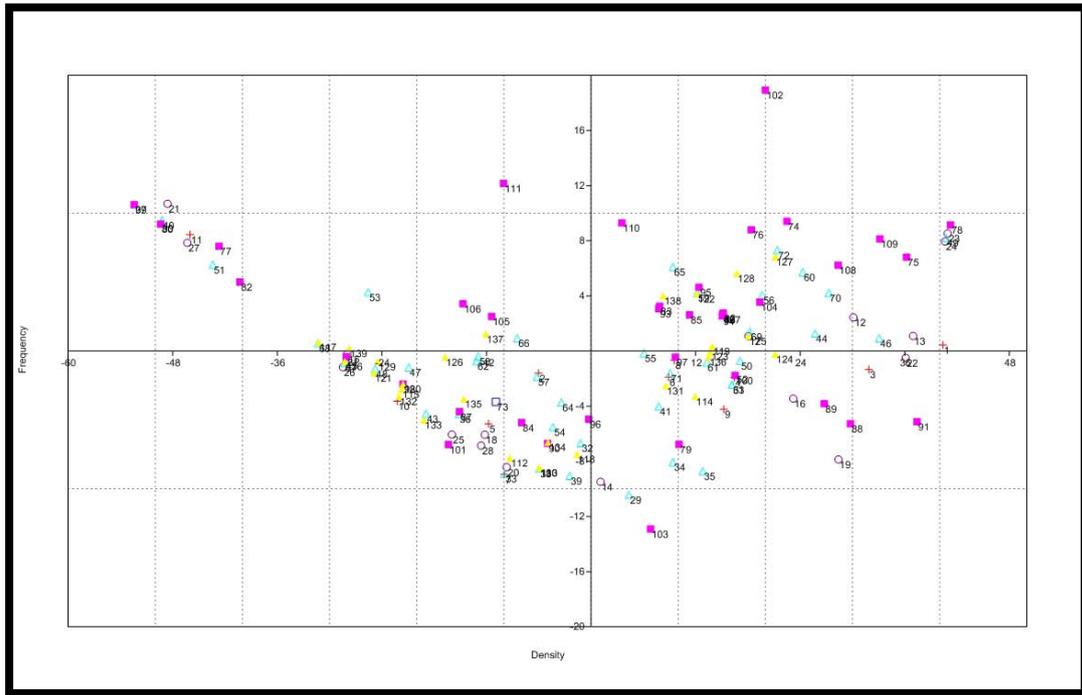


Figure 7: Scatter View of Principal component analysis (PCA)

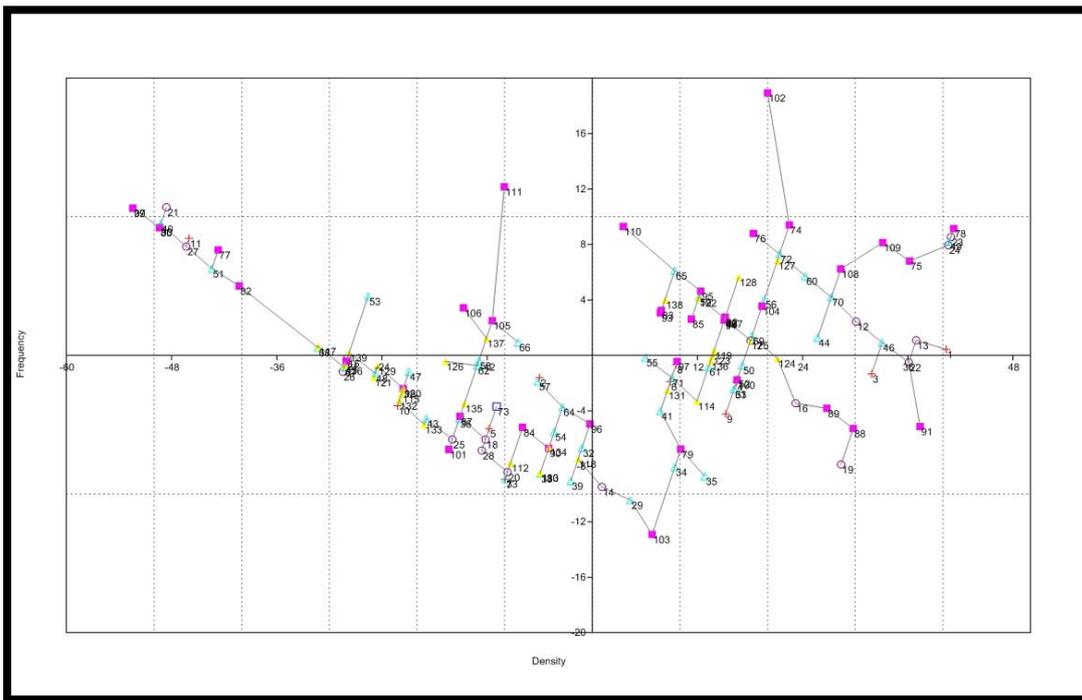


Figure 8: Scatter View of Principal component analysis (PCA) with span

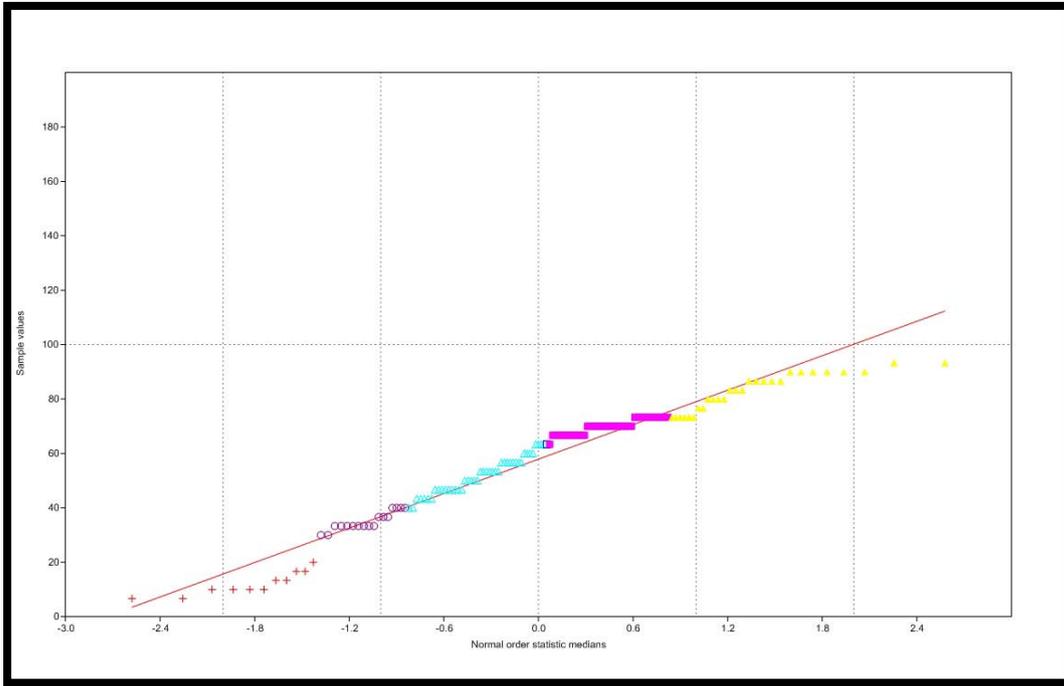


Figure 11: Normal Probability distribution of Frequency

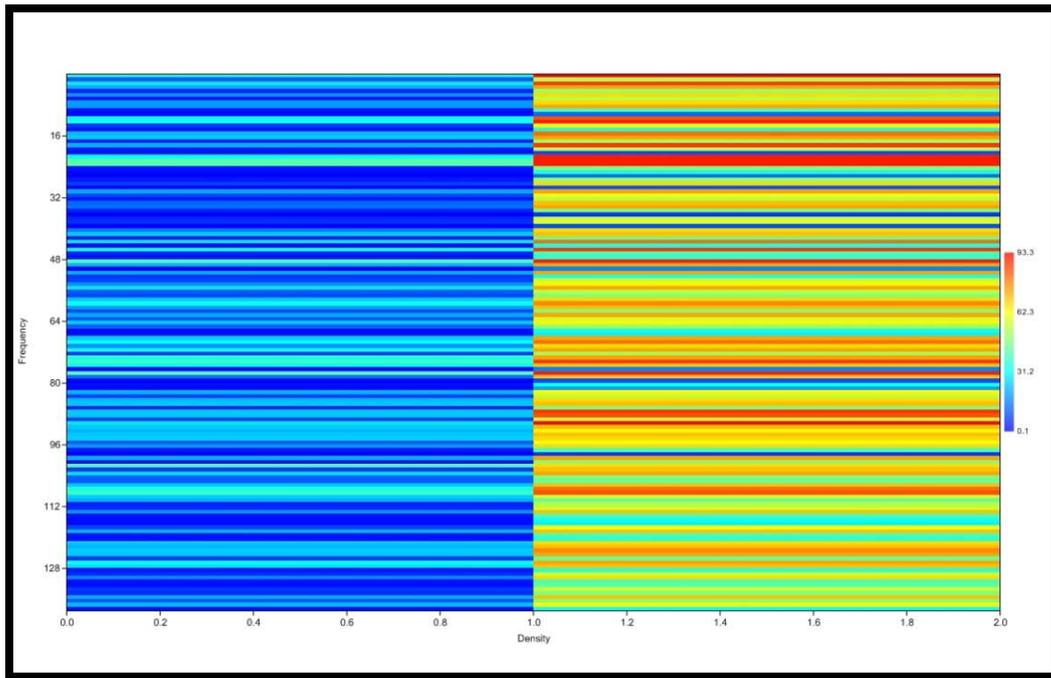


Figure 12: Matrix plot with of Number, Density and Frequency of butterfly species

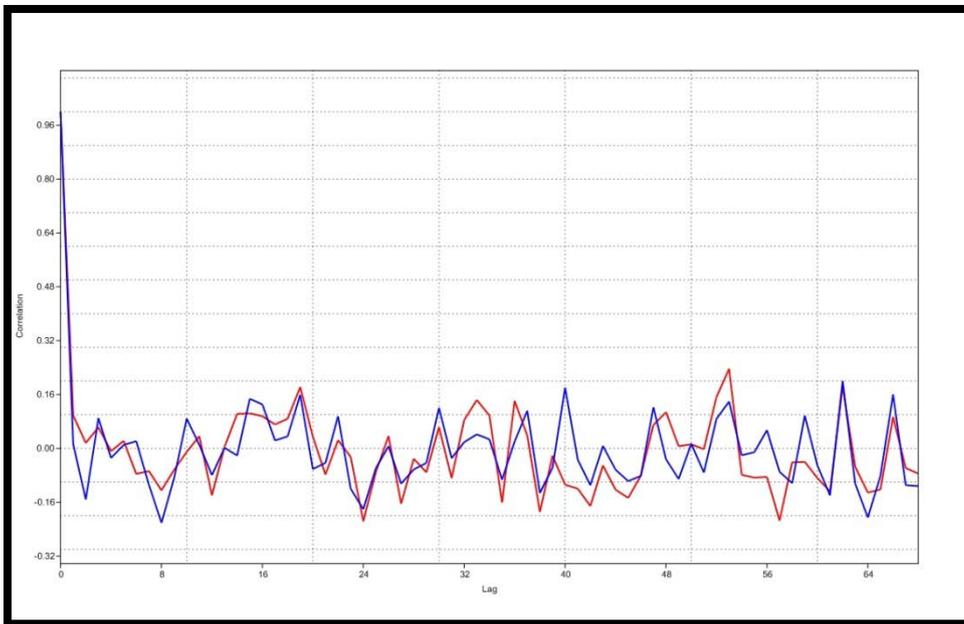


Figure 13: Density and Frequency of butterfly species showing Correlation

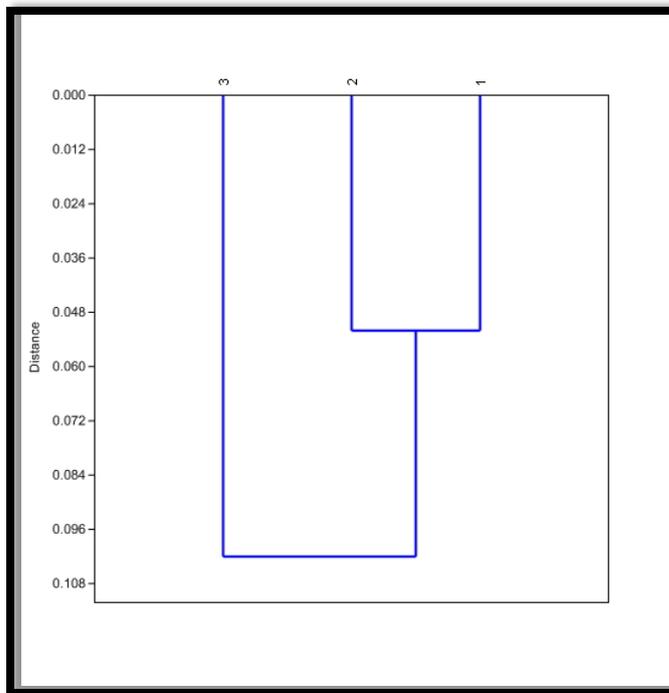


Figure 14: Cluster analysis of three districts (1: Jhargram, 2: Paschim Medinipur, 3: Purba Medinipur) on the basis of various diversity indices

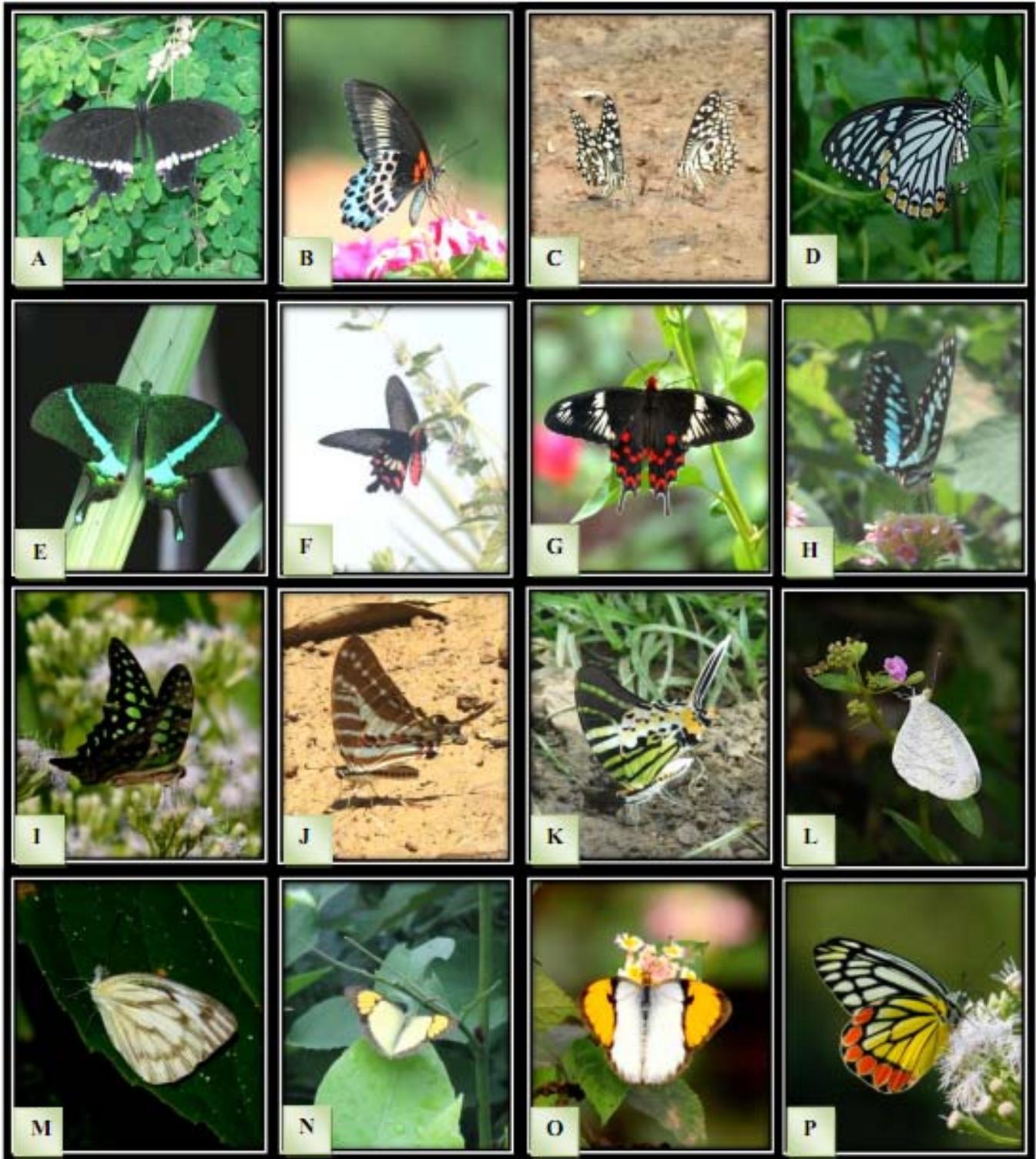


Figure 15: A) Common Mormon, B) Blue Mormon, C) Lime Butterfly, D) Common Mime, E) Common Banded Peacock, F) Common Rose, G) Crimson Rose, H) Common Jay, I) Tailed Jay, J) Spot Swordtail, K) Fivebar Swordtail, L) Psyche, M) Common Gull, N) Yellow Orange Tip, O) White Orange Tip, P) Common Jezebel

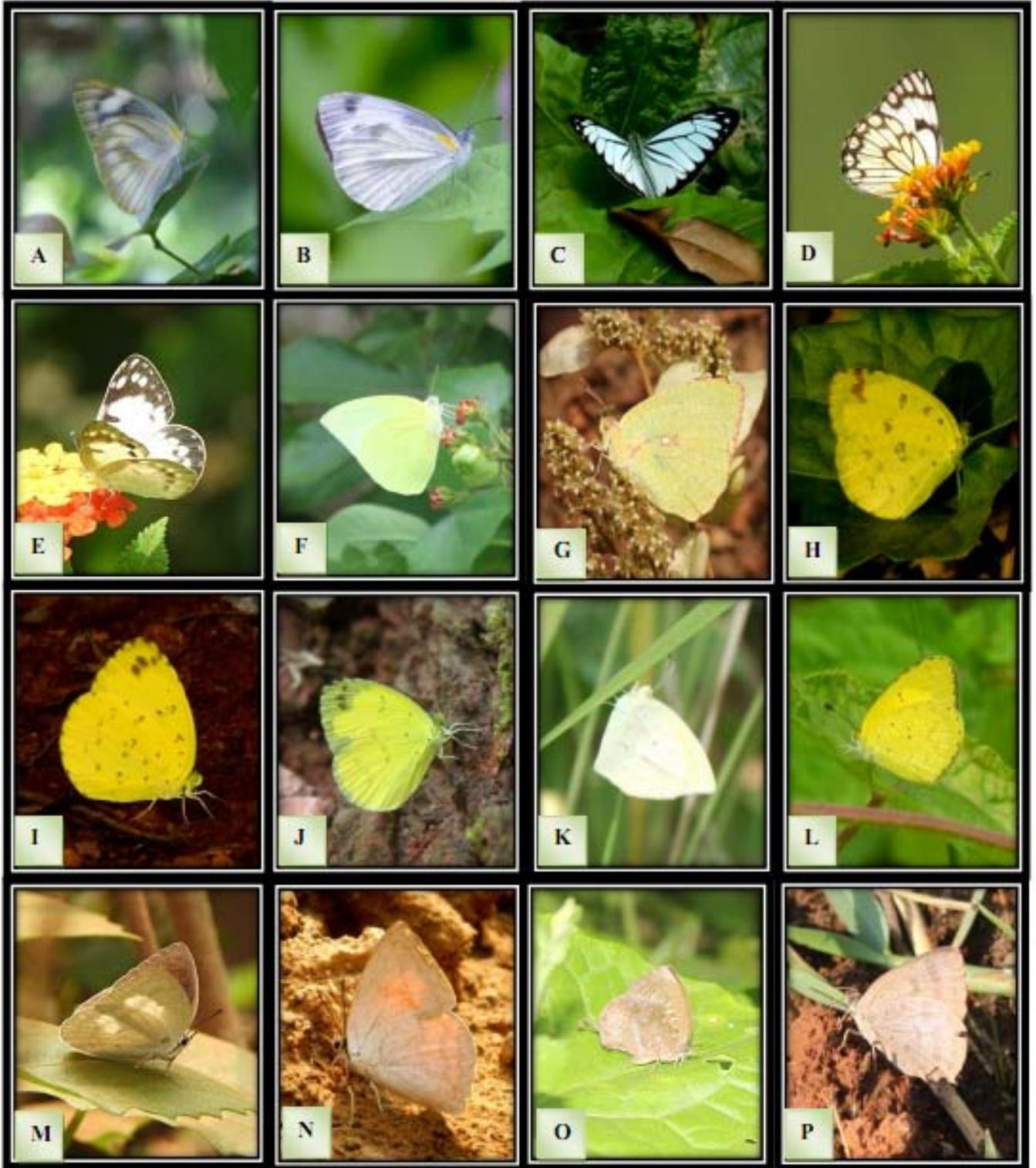


Figure 16: A) Striped Albatross, B) Indian Cabbage White, C) Common Wanderer, D) Pioneer, E) Small Salmon Arab, F) Common Emigrant, G) Mottled Emigrant, H) Common Grass Yellow, I) Three Spot Grass Yellow, J) One Spot Grass Yellow, K) Spotless Grass Yellow, L) Small Grass Yellow, M) Indian Sunbeam, N) Angled Sunbeam, O) Falcate Oakblue, P) Indian Oakblue



Figure 17: A) Large Oakblue, B) Silverstreak Blue, C) Common Guava Blue, D) Purple Leaf Blue, E) Redspot, F) Peacock Royal, G) Broadtail Royal, H) Fluffy Tit, I) Yamfly, J) Monkey Puzzle, K) Indian Red Flash, L) Slate Flash, M) Indigo Flash, N) Common Silverline, O) Common Shot Silverline, P) Long- banded Silverline



Figure 18: A) Common Pierrot, B) *Tarucus* sp., C) Angled Pierrot, D) Zebra Blue, E) Apefly, F) Common Lineblue, G) Tailless Lineblue, H) Common Cerulean, I) Dark Cerulean, J) Common Ciliate Blue, K) Pointed Ciliate Blue, L) Forget Me Not, M) Pea Blue, N) Dark Grass Blue, O) Pale Grass Blue, P) Lesser Grass Blue

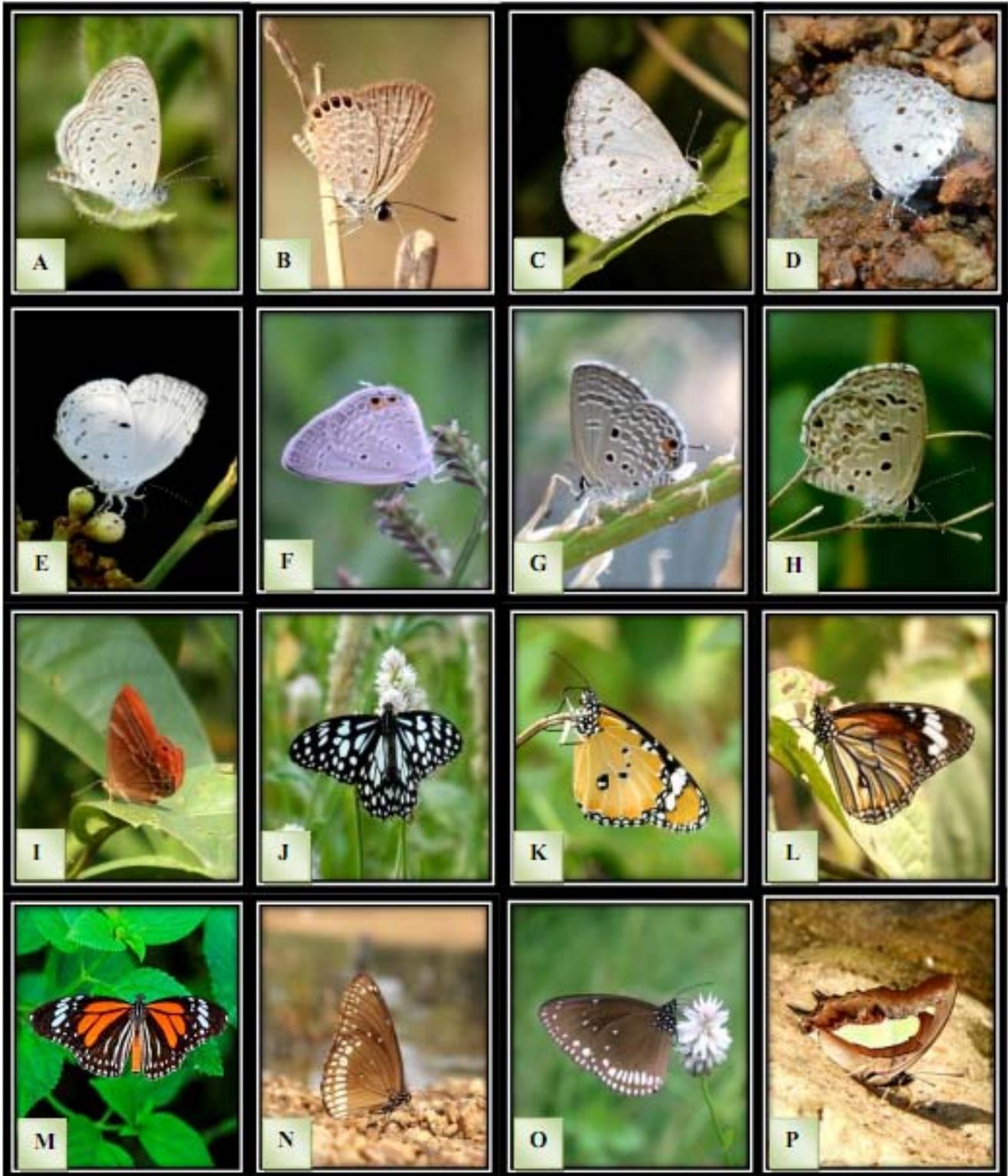


Figure 19: A) Tiny Grass Blue, B) Grass Jewel, C) Common Hedge Blue, D) Malayan, E) Quaker, F) Gram Blue, G) Plains Cupid, H) Lime Blue, I) Double-banded Judy, J) Blue Tiger, K) Plain Tiger, L) Striped Tiger, M) White Tiger, N) Common Crow, O) Brown King Crow, P) Common Nawab



Figure 20: A) Black Rajah, B) Tawny Rajah, C) Common Evening Brown, D) Bamboo Treebrown, E) Common Palmfly, F) Common Bushbrown, G) Dark Brand Bushbrown, H) Common Five Ring, I) Common Four Ring, J) Common Duffer, K) Tawny Coster, L) Common Leopard, M) Commander, N) Angled Castor, O) Common Castor, P) Common Sailer

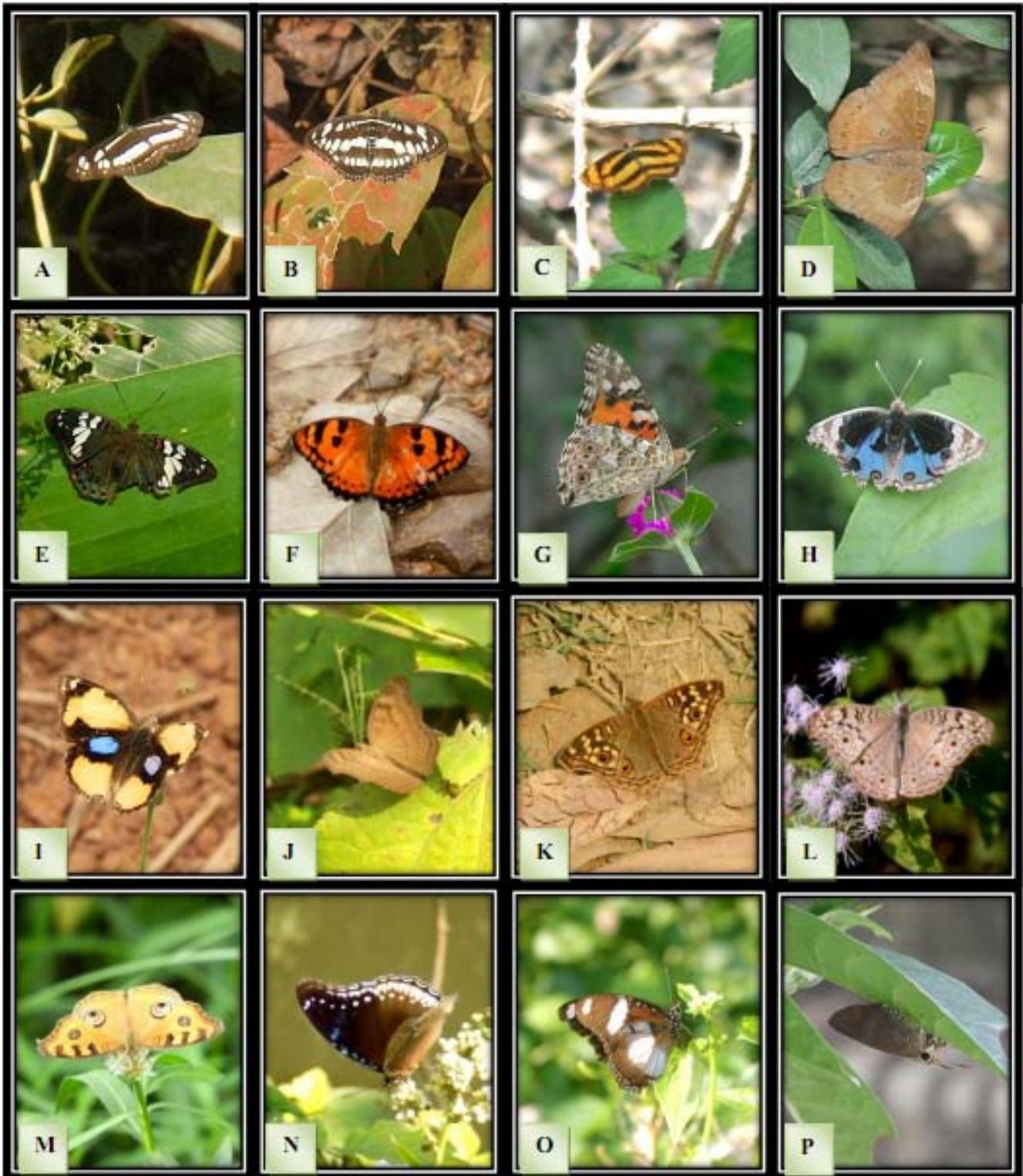


Figure 21: A) Chestnut-streaked Sailer, B) Common Sergeant, C) Common Lascar, D) Common Barron, E) Gaudy Barron, F) Baronet, G) Painted Lady, H) Blue Pansy, I) Yellow Pansy, J) Chocolate Pansy, K) Lemon Pansy, L) Grey Pansy, M) Peacock Pansy, N) Great Eggfly, O) Danaid Eggfly, P) Brown Awl

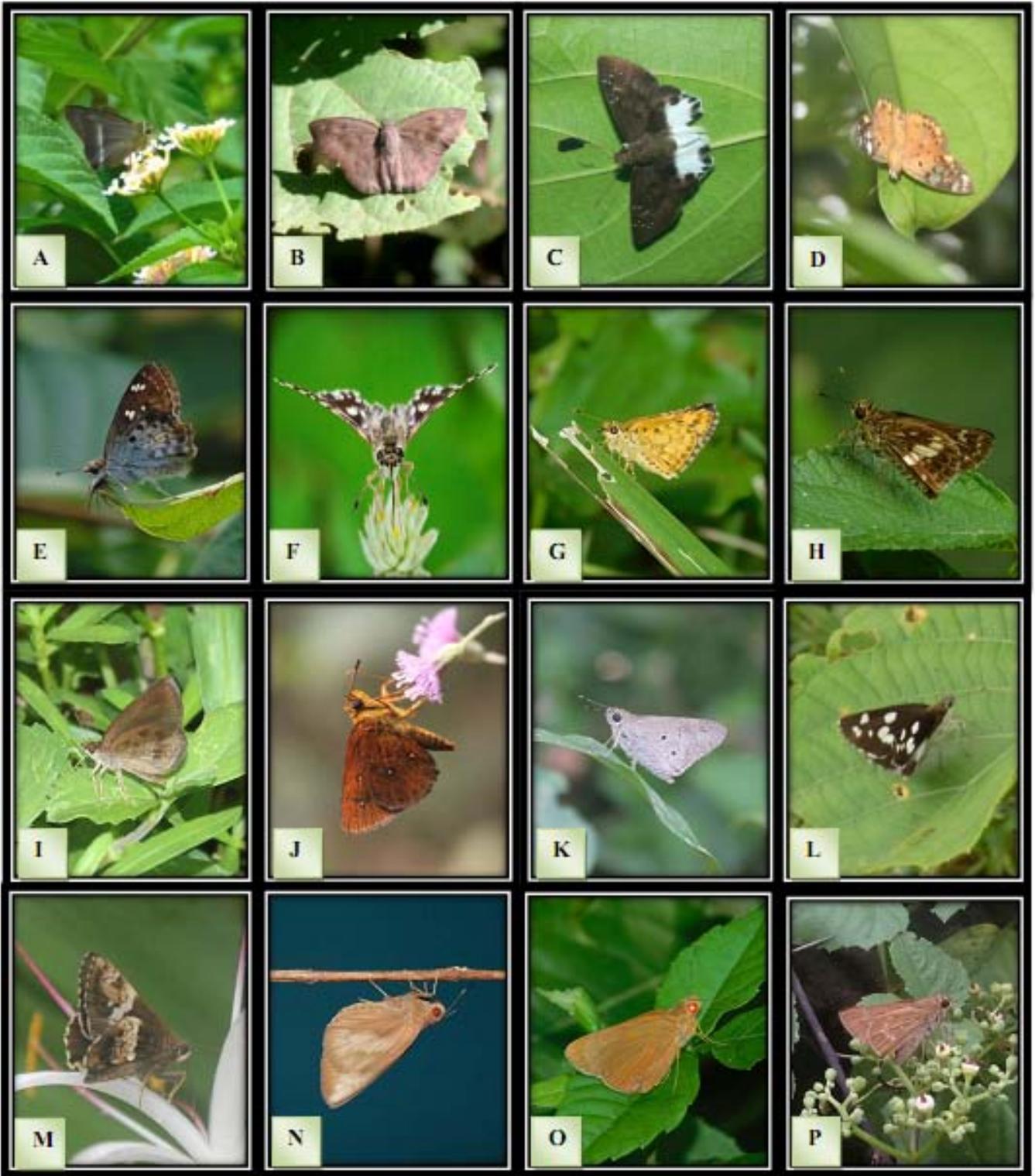


Figure 22: A) Common Banded Awl, B) Common Snow Flat, C) Water Snow Flat, D) Tricolour Pied Flat, E) Golden Angle, F) Indian Skipper, G) Bush Hopper, H) Moore's Ace, I) Forest Hopper, J) Chestnut Bob, K) Indian Palm Bob, L) Grass Demon, M) Tree Flitter, N) Banana Redeye or Banana Skipper, O) Common Red Eye, P) Ceylon Swift (Underwing)

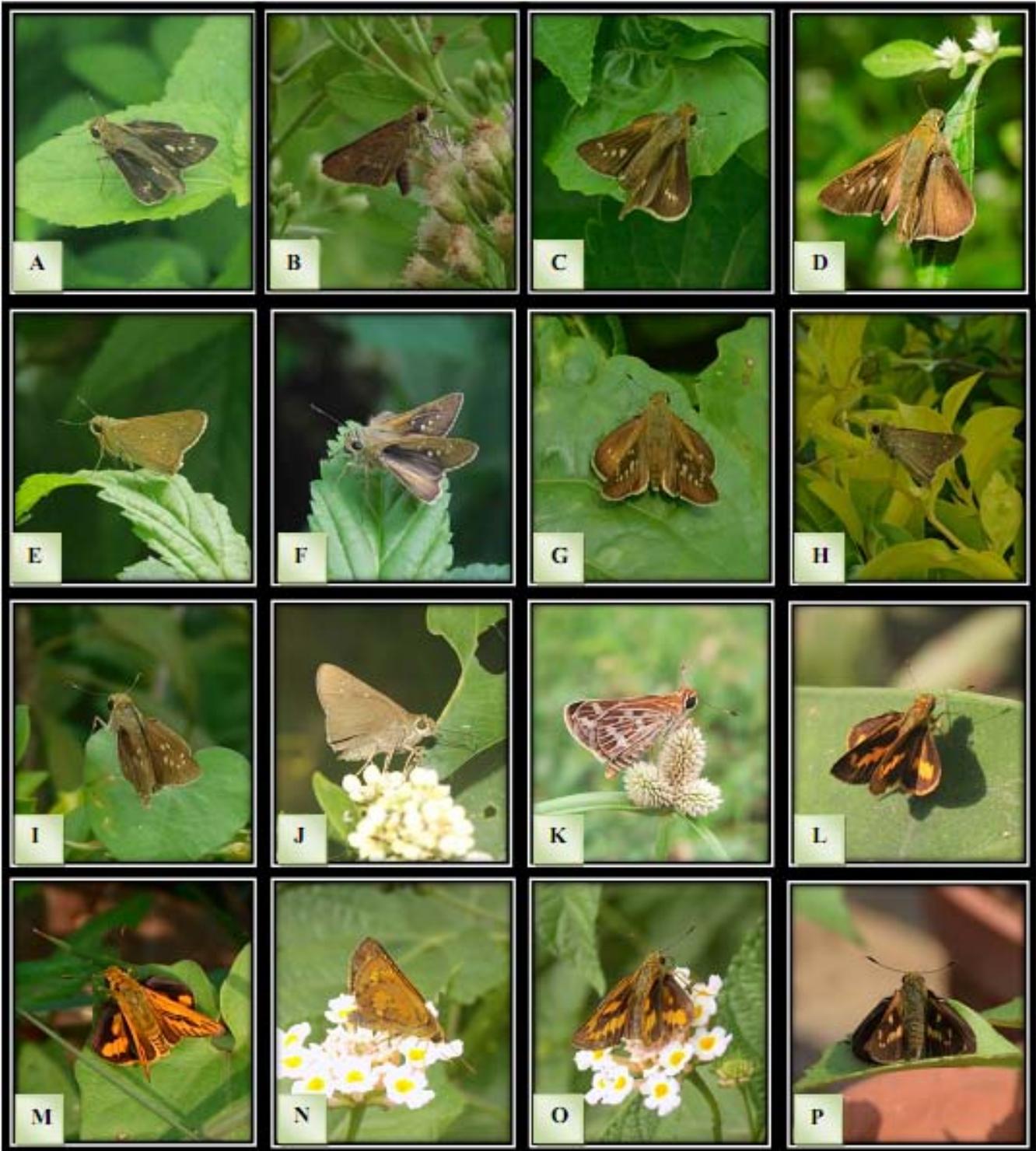


Figure 23: A) Ceylon Swift (Upperwing), B) Evan's Swift (Underwing), C) Evan's Swift (Upperwing), D) Rice Swift, E) Obscure Branded Swift (Underwing), F) Obscure Branded Swift (Upperwing), G) Conjoined Swift, H) Variable Swift (Underwing), I) Variable Swift (Upperwing), J) Paintbush Swift, K) Common Grass Dart, L) Common Dartlet, M) Common or Pale Palm Dart, N) Dark Palm Dart (Underwing), O) Dark Palm Dart (Upperwing), P) Plain Palm Dart