

Research Article

Diversity and distribution of butterflies (Lepidoptera: Rhopalocera) in Rani-Garbhanga Reserve Forest of Kamrup, Assam, India

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ABSTRACT

The present study on the diversity and distribution of butterflies in the Rani and Garbhanga Reserve Forest of Assam was carried out from February 2021 to July 2024. The data of butterflies were collected in the Pre-monsoon, monsoon and retreating monsoon seasons using line transects and visual encounter survey (VES) methods. The study encountered altogether 2,178 individuals of butterflies belonging to 306 species under six families, 25 sub-families and 170 genera. Of the total 306 species, 27 species belonged to the family Papilionidae, 23 species were Pieridae, 114 were Nymphalidae, 72 were Lycaenidae, 3 were Riodinidae, and 67 species fell under the Hesperidae family. The family Nymphalidae showed the highest diversity of butterflies, with 114 species, whereas the family Riodinidae showed the smallest butterfly family with only three species. Again, as per IUCN category status, there were only 23 species recognised as Least Concern, and the remaining 283 species were not being assessed. Under the IWPA (Act) of 2022, only five species were categorized as Schedule I, viz., *Discophora sondaica* Boisduval, 1836, *Stichopthalma camadeva* Westwood, 1848, *Elymnias peali* Wood-Mason, 1883, *Lethe europa* Fabricius, 1775, and *Hypolycaena othona* Hewitson, 1865 and 66 species were listed as Schedule II species. However, the present study has reported that altogether 52 species were endemic butterflies in the region, those are present in Rani-Garbhanga Reserve Forest, where the family Nymphalidae reported the highest of 28 endemic species, followed by the Hesperidae with 12 species, Lycaenidae with six, Pieridae with three, Papilionidae reported two, and the family Riodinidae with one endemic species. The present work highlighted the conservation priority for both the reserve forests to protect the endemic and Schedule species of Butterflies in Assam.

Keywords: Butterflies, Diversity, Rani-Garbhanga Reserve Forest, Kamrup, Assam

INTRODUCTION

Northeast India (NE India), the parts of Eastern Himalaya, is one of the most important hotspots of biological diversity (Myers *et al.*, 2000; Lepcha & Thapa, 2025). The region, by virtue of its varied topography, dense forests, and hot and humid climate, harbours a rich diversity of butterfly fauna, including many rare and endemic species (Mani, 1986). Again, the butterflies are among the few insect groups that have been systematically studied to a very large extent in India (Varshney & Chanda, 1971). Moreover, the works on the butterflies of the northeastern region of India have been done extensively by various authors, viz., Marshall & de Niceville (1882), de Niceville (1886), Antram (1924), Evans (1932) and the fauna volumes by Bingham (1905) and Talbot (1947), etc. Doubleday (1845) had worked on the butterflies in the state of Assam, particularly in a certain district. Apart from diversity and species assemblages, the area supports large numbers of rare and endemic butterflies in the region (Evans, 1932; Kunte *et al.*, 2012; Saikia, 2018; Ghatak & Roy, 2013; Singh, 2017; Wynter-Blyth, 1957). While the global diversity of butterflies supports nearly 18,000 species, India hosts about 1,403 species and subspecies of butterflies (Smetacek, 2025). The forests of Assam and northeast India are very rich in butterfly diversity

(Barua *et al.* 2004; Thapa *et al.*, 2025; Saikia *et al.*, 2009, 2014; Saikia, 2011; Kunte *et al.*, 2012, 2018; Ghatak & Roy, 2013; Singh, 2017). Because of their suitable climate, vegetation structure, and topographic conditions, Evans (1932) had suggested that Northeast India has supported more than 962 species of butterflies, of which 93 species are endemic to this region (Evans, 1932; Wynter-Blyth, 1957). However, very limited works related to its ecology, diversity, species assemblages, and conservation have been done on butterflies in the North-eastern region, except few works such as Saikia *et al.*, 2009; 2010, 2015; Saikia, 2011, 2018; Kunte *et al.*, 2012; Saikia & Saikia, 2014 and Singh, 2017). Saikia *et al.* (2005, 2010) have studied the diversity, life cycle generation and seasonal variation of butterflies in the greater Jalukbari area of Assam. Again, Saikia (2011, 2014) has analysed the impact of habitat degradation on Nymphalid butterflies in the protected and unprotected reserve forest of Assam and the urban altered forest of Gauhati University premises. Gogoi *et al.* (2014) have reported certain rare butterflies in Manas National Park. Saikia (2018) has studied the diversity and species assemblages of butterflies in Nameri National Park of the North Bank landscapes of Assam. Thapa *et al.* (2025) have studied butterfly diversity in Ranga Reserve Forest of the North Bank landscapes of Assam.

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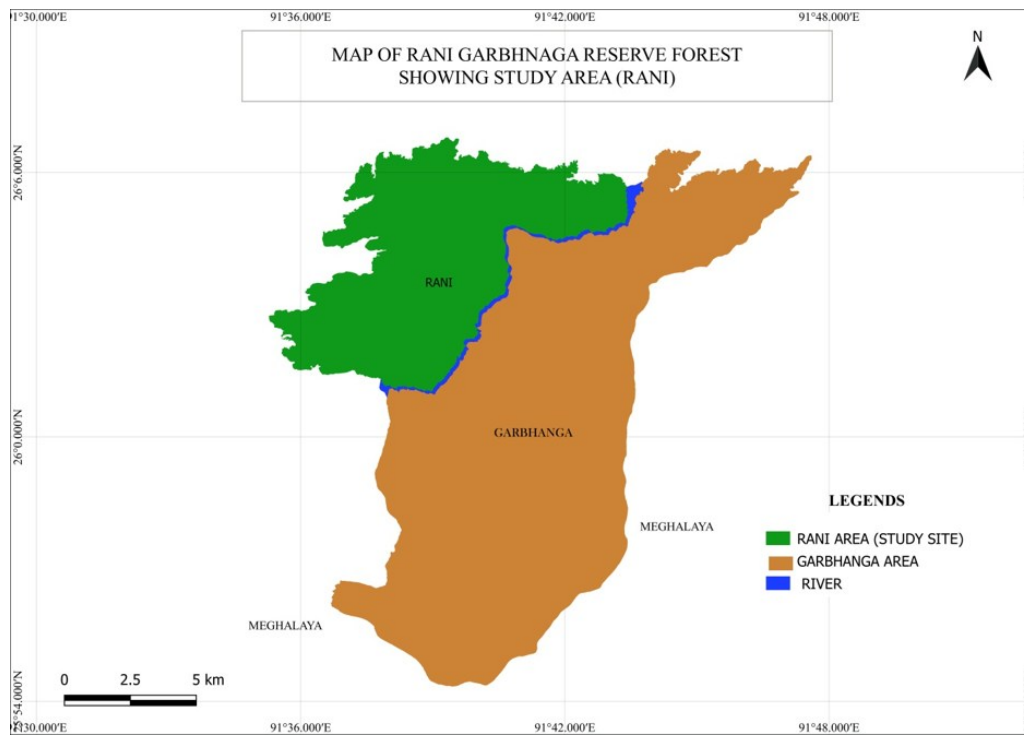


Figure 1. Showing the map of the study area (Rani-Garbhanga RF, Assam)

MATERIALS AND METHODS

STUDY AREA

The study area of Rani Reserve Forest (RRF) and Garbhanga Reserve Forests (GRF) (Coordinates: RRF: 91° 33' 16" E to 91° 55' 24" E longitude and 26° 06' 41" N to 26° 01' 15" N latitude; GRF: 91° 36' 25" E to 91° 47' 45" E longitude and 26° 05' 31" N to 25° 54' 12" N latitude) are located in Southern bank of the River Brahmaputra in Kamrup district of Assam covering an area of 254.85 km² (See Figure 1). It is located at an aerial distance of 10 km² from the Guwahati Metropolitan City. The study area is also contiguous with the Jarasal-Kwasing Reserve, Nakhalliyang Wildlife Sanctuary, and Jirang Unclassed State Forest of the neighbouring Meghalaya. The forests are mainly represented by sub-type moist deciduous forests (Champion & Seth, 1968) and are dominated by Sal (*Shorea robusta*) and Bamboo (*Dendrocalamus hamiltonii*). Other important vegetation of the study area are *Garcinia cawa* and *G. pedunculata*, *Gmelina arborea* Roxburgh, *Lagerstroemia parviflora* Roxburgh, *Schima wallichii* Choisy, *Dillenia pentagyna* Roxburgh, *Phyllanthus emblica* Linnaeus, *Premna latifolia* Roxburgh, *Aporosa roxburghii* Baillon, *Dendrocalamus hamiltonii*, *Eupatorium odoratum* Linnaeus, *Imperata cylindrical* (Linnaeus) Beauverd, *Ziziphus mauritiana* Miller, *Entada phaseoloides* Merrill, *Amoora spectabilis* Miquel, *Artocarpus chaplasha* Roxburgh and *Michelia champaca* Linnaeus, etc.

It is chiefly located in the hilly terrain covering a small-extended plain in the downslopes of the hills. The hills are a continuation in the form of spurs of the Khasi Hill ranges of the Eastern Himalayan biodiversity hotspots. In plains, the forests are located in alluvial terrain, and these are cut up by numerous narrow, winding, low-lying tracts. The study area has a unique geologic and physiographic makeup and is composed of a special habitat mosaic (Saikia *et al.* 2009). The climate of the

study area is mesothermal and humid, with heavy rainfall (300 - 450 cm) in addition to periodic wind, storms, and thunder (Barthakur, 1986). Based on temperature, humidity, and precipitation patterns, the climate of RRF and GRF could be divided into four distinct seasons as Pre-monsoon, Monsoon, Retreating monsoon, and winter. The rainfall, fog, and temperature were found to change in relation to different seasons and different physiographic areas within them. The Forest types of the study areas are tropical wet evergreen, tropical semi-evergreen, and tropical moist deciduous types, with the presence of occasional subtropical broad-leafed hill forest.

METHODS OF STUDY

The field surveys were carried out from February 2021 to July 2024 in Rani-Garbhanga Reserve Forest (RGRF) to find out the diversity, distribution and species assemblages of butterflies in the study area. All survey and sampling data were collected for three years, encompassing all four seasons: Pre-monsoon, Monsoon, Retreating Monsoon, and Winter. The data collection of butterflies primarily took place during their active periods and active season, namely from after sunrise and before sunset of a day and during three active seasons, such as Pre-monsoon, Monsoon, and Retreating Monsoon seasons. The Line Transect method was used as per Pollard (1977), Saikia *et al.*, (2009) and Saikia (2011) using Visual Encounter Survey (Heyer *et al.*, 1994) methods.

STUDY DESIGN

For convenience of butterfly's data collection, the entire study area has been divided into seven habitat zones such as Bamboo Brakes (BB), Mixed Deciduous Forest (MDF), Short Grassland (SG), Agricultural Land (AL), Human Habitation (HH), Riparian fringe Forest (RFF) and Secondary Forest (SF) based on existing dominant

vegetation types (as per Champion & Seth, 1968) and topographical and structural characteristics. For time samplings, the research data were collected six hours a day, starting from 07:30 hours to 11:30 hours and 14:00 hours to 17:00 hours.

DATA COLLECTION

During field observation, all the encountered butterflies were collected and noted down in a field notebook. The data were such as the observed locality, the number of each individual of each species, the date and time of collection, and the habitat of each individual recorded. GPS co-ordinates of start and end points were also recorded as latitude and longitude in decimal degrees using an Android mobile phone (NoteCam app). Data were collected along foot trails of each habitat zone in a pre-determined random sampling area. A total of 38.15 km length was surveyed, covering all previously specified seven habitats in **RGRF**. We selected a total of 10 search paths throughout the forests, five paths in Rani Reserve Forest and five paths in Garbhanga Reserve Forest.

The species identification was made as per published books and field guides for butterflies, supplemented with personal data and the expertise of the authors. Species were identified using the taxonomic keys (Evans, 1932; Talbot, 1947), as well as photographic guidebooks (Haribal, 1992; Kehimkar, 2016). If any unknown or new species of butterfly were encountered, photographs of both the upper and underside of that species were taken using a Nikon DSLR Camera.

DATA ANALYSIS

Different diversity indices for the butterfly communities were analyzed using Species Diversity and Richness were calculated by the Shannon-Wiener Diversity Index (*H*). The statistical analysis of the data and preparation of graphs were done using Microsoft Excel software. We used the following expressions for measuring the diversity of butterflies in the **RGRF**.

$$H = - \sum_{i=1}^s P_i \ln P_i$$

$$EH = H / \ln S$$

Where *P_i* is the proportion of species *i* in the *S* made community
S is the total number of species in the community.

We also used the following expression to calculate the Proportional abundance for each habitat of the species:

$$= a/n * 100$$

Where, “a” is no. of particular species and “n” is total no. of individuals of a particular habitat.

RESULTS

The present study encountered altogether 2,178 individuals of butterflies belonging to 306 species under 170 genera, and six (6) families of butterflies in Rani-Garbhangha Reserve Forests (RGRF) (See Table 1). Among all six families of butterflies, the most diverse family was the Nymphalidae family harbouring 114 species belonging to 55 genera, whereas Riodinidae has the lowest diversity, with supporting three species belonging to two different genera (Table 1 & 2). The other four families, namely Lycaenidae, Hesperidae, Papilionidae, and Pieridae, were represented by 72, 67, 27, and 23 species, respectively (Tables 1 & 2; Plates I-VI). Again, among all the butterflies recorded in RGRF, 71 species were protected under various schedules of the Indian Wildlife Protection (Act) 1972 (and latest amendments of 2022) (Anonymous, 2022), of which 66 species were listed as Schedule II and five were Schedule I species. However, as per the IUCN status category of Butterflies in the study area, 23 species were reported as Least Concern, and the rest were not Accessed category (IUCN, 2025). But interestingly, 52 numbers of recorded butterfly species in the study area of RGRF were endemic to NE India (Table 2). Among all the endemic butterflies recorded in the study area, out of 52 endemic butterflies recorded in the study area maximum of 28 species were belonging to Nymphalidae family 12 species belonged to the Hesperidae family, six belonged to the Lycaenidae family, three species from the Pieridae family, two from Papilionidae family and least one species from the Riodinidae family (see Table 2).

Family-wise diversity of butterflies

Among all the butterflies recorded in the study area, belonging to six families, the family Nymphalidae dominated with the highest diversity, 114 species, whereas the Riodinidae family showed the lowest diversity (3 species) in RGRF (Table 1). Study also found that the Garbhanga Reserve Forest (GRF) has higher butterfly diversity (272 species) than the Rani Reserve Forest (RRF) (249 species) (Figure 2). **Diversity of Butterflies** Again, analysis of the Shannon Diversity index, it was found that the diversity of butterfly species was higher in GRF with an index of *H'*= 5.22, in comparison to RRF, where *H'*= 5.159. Similarly, the analysis of the Evenness Index also shows that the evenness index of GRF was 0.92, and the evenness index of RRF was 0.901 (see Figure 3).

Habitat use types of butterflies

During the study period, the butterflies were recorded in all seven types of habitats. The Riparian Fringe Forests areas was used by the highest species of butterflies with 541 individuals under 185 butterfly species followed by

Table 1. Family wise composition of butterflies exhibiting the total number of genera and species in the study area.

Sl. No.	Family	Subfamily	Genera	Species
01	Papilionidae	1	07	27
02	Pieridae	2	10	23
03	Nymphalidae	11	55	114
04	Lycaenidae	7	48	72
05	Riodinidae	1	02	03
06	Hesperidae	3	48	67
Total		25	170	306

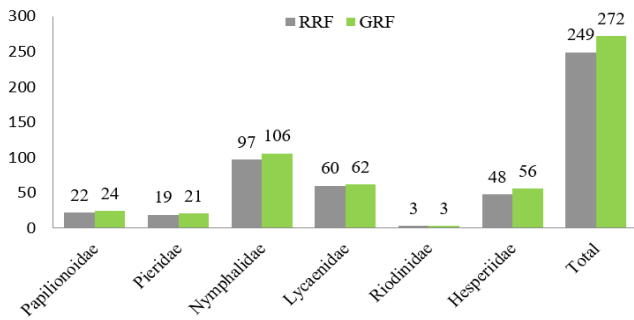


Figure 2. Family-wise distribution of butterflies in both reserve forests

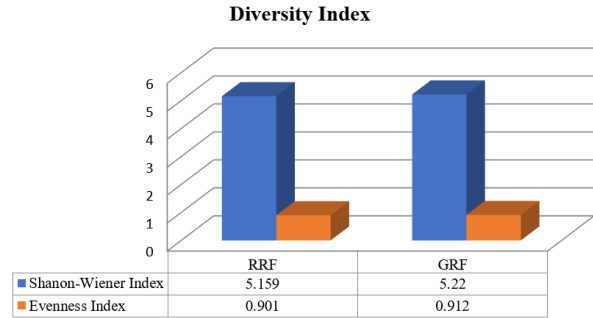


Figure 3. Shanon-Weiner Diversity and Shanon Evenness Index of butterfly species in the study area

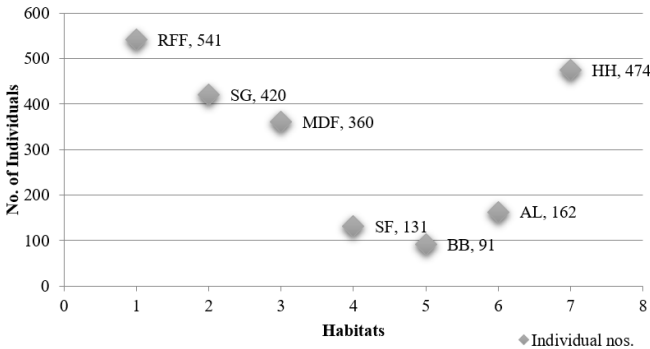


Figure 4. The diagram showing the different habitats used by butterflies ((SG: Short Grassland; BB: Bamboo Brakes; MDF: Mixed Deciduous Forest; AL: Agricultural Land; HH: Human Habitation area; RFF: Riparian Fringe Forest; SF: Secondary Forest)

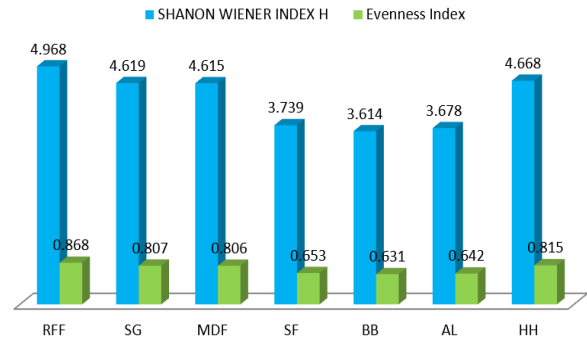


Figure 5. Shanon-Weiner Diversity and Shanon Evenness Index of butterfly species in different habitats of the study area

Human habitation areas (474 individuals with 140 species), Short grassland (420 individuals with 130 species), Mixed deciduous forest (360 individuals with 123 species), Agricultural land (162 individuals with 51 species), Secondary forest (131 individuals with 48 species), whereas, Bamboo brakes (91 individuals with 42 species) was the least used habitat (see Figure 4). Although, Bamboo brakes has recorded smaller number of species but, that habitat harbored unique butterflies' species like Common Duffer (*Discophora sondaica*), Constable (*Dichorragia nesimachus*) and Jungle Queen etc.

Habitat-wise diversity of Butterflies

Among the seven habitat types in the study area, the Shannon-Weiner diversity for butterfly communities was highest in the Riparian fringe forests outcome with a diversity index of $H' = 4.968$, but least in the Bamboo brakes, with a $H' = 3.614$. Similarly, Shannon's Evenness Index was highest in RFF (0.868) compared to BB (0.631) (Figure 5). The higher diversity and evenness in RFF may be attributed to the availability of continuous moisture, abundance of nectar and host plants. In contrast, BB being more homogeneous and seasonally dry, likely offers fewer ecological niches and limited host plant diversity, resulting in lower butterfly richness and evenness.

DISCUSSION

The Garbhanga and Rani Reserve Forest, located in the Indo-Burma biodiversity hotspot, harboured a high diversity and unique composition of butterfly communities. The geographical location of any study area

initiates the formation of a good habitat that can support rich butterfly fauna, as the present study revealed that the Garbhanga and Rani Reserve Forest is a resource-enriched habitat for butterflies within the Northeastern states of India. The reserve forest supports a substantial number of butterfly species that are endemic, rare, and legally protected under the Wildlife Protection Amendment (), 2022. During the study, 2,178 individuals from 306 species of butterflies were recorded from the study area (Tables 1 & 2), and this result suggested that the family Nymphalidae was the most dominant family with 114 species under 55 genera in the study area (Table 2, Figure 2, Photo plate I-VI). This statement is supported by Eswaran and Pramod (2005) and Krishnakumar *et al.* (2008) in their earlier studies. The authors mentioned that the members of the Nymphalidae were always dominant in the tropical region because most of the Nymphalid butterflies are polyphagous in nature, consequently helping them to survive in all habitats. Among the Nymphalid butterflies, Glassy Tiger (*Parantica aglea*), Large Yeoman (*Cirrochroa aoris*), and Grey Pansy (*Junonia atlites*) have been observed frequently, which was not reported earlier. But the study of Saikia *et al.* (2010) found dominance of Common Sailer (*Neptis hylas*), Lemon Pansy (*Junonia lemonias*), Common Crow (*Euploea core*), and Common Bushbrown (*Mycalesis perseus*). As well as, Among all the recorded butterflies, Common Emigrant (*Catopsilia pomona*) were the most observed species. The systematic study and continuous observation suggested that the months of March-April were the best months for the butterflies. In this season, a variety of host plants as well as nectar plants grow, and there are plenty of food sources in the study area.

Table 2. Diversity and abundance of butterflies in Rani and Garbhanga RF of Assam during the study period (SC- Schedule; LC- Least Concern; NA- Not Applicable).

Sl. No.	Family/Species	Proportional Abundance of butterfly species		Conservation Status		Endemic to NE India
		RRF	GRF	WPA, 1972	IUCN	
01	Family: Papilionidae	0.2	0.42			Endemic
	White Dragontail- <i>Lamproptera curius</i>					
02	Common Jay- <i>Graphium doson</i>	1.01	1.52			
03	Great Jay- <i>Graphium eurypylus</i>	1.31	0	SC II		
04	Tailed Jay- <i>Graphium agamemnon</i>	0.91	0.59			
05	Common Bluebottle- <i>Graphium sarpedon</i>	1.82	0.5	SC II	LC	
06	Fourbar Swordtail- <i>Graphium agetes</i>	0.4	0	SC II		
07	Fivebar Swordtail- <i>Graphium antiphates</i>	1.11	1.18			
08	Chain Swordtail- <i>Graphium aristeus</i>	0	0.16	SC II		
09	Lesser Zebra- <i>Graphium macareus</i>	0	0.16			
10	Great Zebra- <i>Graphium xenocles</i>	0.81	0			Endemic
11	Spotted Zebra- <i>Graphium megarus</i>	0	0.08	SC II		
12	Common Windmill- <i>Byasa polyeuctes</i>	0.3	0.16			
13	Common Batwing- <i>Atrophaneura varuna</i>	0.3	0.16		LC	
14	Lesser Batwing- <i>Atrophaneura aidoneus</i>	0	0.08		LC	
15	Common Rose- <i>Pachliopta aristolochiae</i>	1.72	1.27		LC	
16	Common Birdwing- <i>Troides helena</i>	0.4	0.5		LC	
17	Golden Birdwing - <i>Troides aeacus</i>	0.2	0.33	SC II	LC	
18	Common Mime- <i>Papilio clytia</i>	0.81	0.93	SC II		
19	Great Blue Mime- <i>Papilio paradoxa</i>	0.1	0.25	SC II		
20	Common Mormon- <i>Papilio polytes</i>	2.33	2.2			
21	Great Mormon- <i>Papilio agenor</i>	0.4	0.76			
22	Common Raven- <i>Papilio castor</i>	0	0.25		LC	
23	Red Helen- <i>Papilio helenus</i>	0.5	0.67		LC	
24	Yellow Helen- <i>Papilio nephelus</i>	0.3	0.25			
25	Lime Butterfly- <i>Papilio demoleus</i>	0.91	0.93			
26	Spangle- <i>Papilio protenor</i>	0.2	0.25			
27	Paris Peacock- <i>Papilio paris</i>	0.2	0.42			
28	Family: Pieridae	0.3	0.33	SC II	LC	
	One-Spot Grass Yellow- <i>Eurema andersonii</i>					
29	Common Grass Yellow- <i>Eurema hecabe</i>	1.82	1.43		LC	
30	Three-Spot Grass Yellow- <i>Eurema blanda</i>	0.6	1.01			
31	Small Grass Yellow- <i>Eurema brigitta</i>	0.2	0.08		LC	
32	Tree Yellow- <i>Gandaca harina</i>	0.4	0.25			
33	Common Emigrant- <i>Catopsilia pomona</i>	2.83	3.13			
34	Mottled Emigrant- <i>Catopsilia pyranthe</i>	2.53	1.69			
35	Great Orange Tip- <i>Hebomoia glaucippe</i>	0.6	0.84			
36	Yellow Orange Tip- <i>Ixias pyrene</i>	0.3	0.16			
37	Eastern Striped Albatross- <i>Appias olferna</i>	0.6	1.1			Endemic
38	Chocolate Albatross- <i>Appias lycinda</i>	0.81	1.18	SC II		
39	Plain Puffin- <i>Appias indra</i>	0.2	0.08	SC II		
40	Spot Puffin- <i>Appias lalage</i>	0.2	0			
41	Indian Cabbage White- <i>Pieris canidia</i>	1.11	1.35			
42	Large Cabbage White- <i>Pieris brassicae</i>	0	0.16		LC	
43	Common Gull- <i>Cepora nerissa</i>	0.2	0			
44	Lesser Gull- <i>Cepora nadina</i>	0	0.25	SC II		
45	Red-Based Jezebel- <i>Delias pasithoe</i>	0.5	0.33			
46	Red- Spot Jezebel- <i>Delias descombesi</i>	0.3	0.5			Endemic
47	Redbreast Jezebel- <i>Delias acalis</i>	0	0.16			
48	Painted Jezebel- <i>Delias hyparete</i>	0.2	0.42			
49	Yellow Jezebel- <i>Delias agostina</i>	0	0.08			Endemic
50	Psyche- <i>Leptosia nina</i>	1.52	0.93			

Table 2 Contd..

51	Family: Nymphalidae	0.91	0.84		
	Glassy Tiger- Parantica aglea				
52	Chocolate Tiger- Parantica melaneus	0.1	0		
53	Blue Tiger- Tirumala limniace	0.7	0.84		
54	Dark Blue Tiger- Tirumala septentrionis	0.4	0.25		
55	Plain Tiger- Danaus chrysippus	0.7	0.5		LC
56	Striped Tiger- Danaus genutia	0.5	0.25		
57	Striped Blue Crow- Euploea mulciber	0.5	0.33		
58	King Crow- Euploea klugii	0.3	0.16		
59	Magpie Crow- Euploea radamanthus	0.2	0.33		
60	Long Branded Blue Crow- Euploea algea	0.4	0.25	SC II	
61	Double-branded Crow- Euploea sylvester	0	0.16		
62	Common Crow- Euploea core	0.91	0.59		LC
63	Common Nawab- Charaxes bharata	0.6	0.59	SC II	
64	Great Nawab- Charaxes eudamippus	0.1	0.08		
65	Jewelled Nawab- Charaxes delphis	0.1	0.08	SC II	Endemic
66	Tawny Rajah- Charaxes bernardus	0.4	0.59	SC II	
67	Variiegated Rajah- Charaxes kahruba	0.2	0.33	SC II	
68	Black Rajah- Charaxes solon	0.2	0.16	SC II	
69	Yellow Rajah- Charaxes marmax	0.1	0.16	SC II	
70	Common Faun- Faunis canens	0.1	0.08		Endemic
71	Red Caliph- Enispe euthymius	0	0.08		Endemic
72	Common Duffer- Discophora sondaica	0.3	0.42	SC I	Endemic
73	Jungle Glory- Thaumantis diores	0	0.25		Endemic
74	Northern Jungle Queen- Stichophthalma camadeva	0.6	0.25	SC I	Endemic
75	Common Palmfly- Elymnias hypermnestra	0.5	0.59		
76	Spotted Palmfly- Elymnias malelas	0.3	0.16	SC II	
77	Tiger Palmfly- Elymnias nesaea	0	0.16		Endemic
78	Brahmaputra Palmfly- Elymnias peali	0	0.08	SC I	Endemic
79	Jezebel Palmfly- Elymnias vasudeva	0	0.16	SC II	Endemic
80	Common Evening Brown- Melanitis leda	0.5	0.67		LC
81	Dark Evening Brown- Melanitis phedima	0.2	0.25		
82	Great Evening Brown- Melanitis zitenius	0.1	0.16	SC II	
83	Yellow Kaiser- Penthema lisarda	0.2	0.25	SC II	Endemic
84	Dusky Diadem- Ethope himachala	0.3	0.33		Endemic
85	Bamboo Treebrown- Lethe europa	0.2	0.08	SC I	
86	Banded Treebrown- Lethe confusa	0.3	0.42		
87	Common Red Forester- Lethe mekara	0.3	0.33		Endemic
88	Angled Red Forester- Lethe chandica	0.2	0.33		
89	Tailed Red Forester- Lethe sinorix	0.3	0.16	SC II	Endemic
90	White-striped Ringlet- Ragadia crisilda	0	0.08	SC II	
91	Dark-Brand Bushbrown- Mycalesis mineus	0.2	0.33		
92	Long-Brand Bushbrown- Mycalesis visala	0.3	0.16		
93	White-Bar Bushbrown- Mycalesis anaxias	0.2	0	SC II	
94	Chinese Bushbrown- Mycalesis gotama	0.1	0.08	SC II	Endemic
95	White-Line Bushbrown- Telinga malsara	0.3	0.08		
96	Plain Bushbrown- Telinga malsarida	0.1	0	SC II	Endemic
97	Dark Catseye- Zibaetis scylax	0.3	0		Endemic
98	Nigger- Orsotriaena medus	0.6	0.76		
99	Common Four-Ring- Ypthima huebneri	0.5	0.25		
100	Common Five-Ring- Ypthima baldus	0.7	0.42		
101	Tawny Coster- Acraea terpsicore	0.3	0.42		
102	Yellow Coster- Acraea issoria	0.1	0.33		
103	Leopard Lacewing- Cethosia cyane	0.4	0.25		
104	Red Lacewing- Cethosia biblis	0.1	0.08	SC II	
105	Common Leopard- Phalanta phalantha	0.4	0.42		LC

Table 2 Contd..

106	Cruiser- <i>Vindula erota</i>	0.3	0.33			
107	Common Yeoman- <i>Cirrochroa tyche</i>	0.3	0.33			
108	Large Yeoman- <i>Cirrochroa aoris</i>	0.81	1.1			
109	Vagrant- <i>Vagrans egista</i>	0.1	0			
110	Commander- <i>Moduza procris</i>	0.3	0.33			
111	Common Sergeant- <i>Athyma perius</i>	0.33	0.33			
112	Studded Sergeant- <i>Athyma asura</i>	0.2	0.16	SC II		
113	Dot-Dash Sergeant- <i>Athyma kanwa</i>	0.3	0.08	SC II		Endemic
114	Blackvein Sergeant- <i>Athyma ranga</i>	0.2	0.16	SC II		
115	Staff Sergeant- <i>Athyma selenophora</i>	0.2	0.08			
116	Small Staff Sergeant- <i>Athyma zeroa</i>	0	0.16			
117	Colour Sergeant- <i>Athyma inara</i>	0.4	0.25			
118	Knight- <i>Lebadea martha</i>	0.3	0.42			
119	Common Lascar- <i>Pantoporia hordonia</i>	0.5	0.33			
120	Perak Lascar- <i>Pantoporia paraka</i>	0.2	0.33			Endemic
121	Common Sailer- <i>Neptis hylas</i>	0.4	0.42			
122	Clear Sailer- <i>Neptis clinia</i>	0.2	0.08	SC II		
123	Dingy Sailer- <i>Neptis pseudovikasi</i>	0	0.16			
124	Namba Sailer- <i>Neptis namba</i>	0.2	0			Endemic
125	Small Yellow Sailer- <i>Neptis miah</i>	0.2	0.16			Endemic
126	Short-Banded Sailer- <i>Phaedyma columella</i>	0.1	0.25	SC II		
127	Clipper- <i>Parthenos sylvia</i>	0.4	0	SC II		
128	Common Baron- <i>Euthalia aconthea</i>	0.4	0.25	SC II		
129	Powdered Baron- <i>Euthalia monina</i>	0.2	0.16			Endemic
130	Gaudy Baron- <i>Euthalia lubentina</i>	0	0.16			
131	Grey Baron- <i>Euthalia anosia</i>	0	0.08	SC II		Endemic
132	White-Edged Blue Baron- <i>Euthalia phemius</i>	0	0.08			Endemic
133	Grey Count- <i>Tanaecia lepidea</i>	0.7	0.93	SC II		
134	Common Earl- <i>Tanaecia julii</i>	0.5	0.5			
135	Plain Earl- <i>Tanaecia jahnu</i>	0.3	0.16			Endemic
136	Red-Spot Duke- <i>Dophla evelina</i>	0	0.16	SC II		
137	Dark Archduke- <i>Lexias dirtea</i>	0.3	0.42	SC II		Endemic
138	Great Archduke- <i>Lexias cyanipardus</i>	0.2	0.08	SC II		Endemic
139	Common Maplet- <i>Chersonesia risa</i>	0.2	0.42			
140	Wavy Maplet- <i>Chersonesia intermedia</i>	0	0.16	SC II	LC	Endemic
141	Common Map- <i>Cyrestis thyodamas</i>	0	0.16			
142	Constable- <i>Dichorragia nesimachus</i>	0.1	0.08			
143	Popinjay- <i>Stibochiona nicea</i>	0.3	0.5			
144	Common Castor- <i>Ariadne merione</i>	0.4	0.67			
145	Angled Castor- <i>Ariadne ariadne</i>	0.5	0.16			
146	Indian Purple Emperor- <i>Mimathyma ambica</i>	0.2	0.25			
147	Sergeant Emperor- <i>Mimathyma chevana</i>	0	0.08	SC II		
148	Black Prince- <i>Rohana parisatis</i>	0.2	0.33			
149	Courtesan- <i>Euripus nyctelius</i>	0.3	0.42	SC II		Endemic
150	Pasha- <i>Herona marathus</i>	0.1	0.16	SC II		
151	Circe- <i>Hestina nama</i>	0.1	0.16			
152	Common Jester- <i>Symbrenthia lilaea</i>	0.3	0.33			
153	Spotted Jester- <i>Symbrenthia hypselis</i>	0.2	0.08			
154	Indian Red Admiral- <i>Vannesa indica</i>	0.2	0			
155	Blue Admiral- <i>Kaniska canace</i>	0.3	0.16			
156	Grey Pansy- <i>Junonia atlites</i>	1.01	1.6			
157	Chocolate Pansy- <i>Junonia iphita</i>	0.6	0.67			
158	Peacock Pansy- <i>Junonia almana</i>	0.5	0.93		LC	
159	Lemon Pansy- <i>Junonia lemonias</i>	0.91	0.84			
160	Yellow Pansy- <i>Junonia hierta</i>	0.81	0.5		LC	
161	Blue Pansy- <i>Junonia orithya</i>	0	0.16		LC	

Table 2 Contd..

162	Great Eggfly- <i>Hypolimnas bolina</i>	0.2	0.5		
163	Orange Oakleaf- <i>Kallima inachus</i>	0.3	0.33		
164	Autumn Leaf- <i>Doleschallia bisaltide</i>	0.1	0.16	SC II	
165	Family: Lycaenidae	0.3	0.42		
	Acute Sunbeam- <i>Curetis acuta</i>				
166	Common Gem- <i>Poritia hewitsoni</i>	0	0.25	SC II	
167	Plain Mottle- <i>Allotinus unicolor</i>	0.2	0.08		
168	Forest Pierrot- <i>Taraka hamada</i>	0.2	0.25		
169	Apefly- <i>Spalgis epeus</i>	0.5	0.67		
170	Club Silverline- <i>Spindasis syama</i>	0.4	0.25		
171	Long-Banded Silverline- <i>Spindasis lohita</i>	0.5	0.59	SC II	
172	Common Ciliate Blue- <i>Anthene emolus</i>	0.4	0.76		
173	Pointed Ciliate Blue- <i>Anthene lycaenina</i>	0.1	0.25	SC II	
174	Common Lineblue- <i>Prosotas nora</i>	0.4	0.42		
175	Tailless Lineblue- <i>Prosotas dubiosa</i>	0.5	0.33	SC II	
176	Banded Lineblue- <i>Prosotas aluta</i>	0.3	0	SC II	
177	Lineblue Butterfly- <i>Nacaduba spp.</i>	0.3	0.08		
178	Pale Four-Lineblue- <i>Nacaduba hermus</i>	0.2	0	SC II	
179	Angled Pierrot- <i>Caleta decidia</i>	0.4	0.42		
180	Elbowed Pierrot- <i>Caleta elna</i>	0.3	0.33		
181	Common Pierrot- <i>Castalius rosimon</i>	0.7	0.84		
182	Little Tiger Pierrot- <i>Tarucus balkanica</i>	0.81	0.1		
183	Dark Pierrot- <i>Tarucus ananda</i>	0.2	0.25		
184	Red Pierrot- <i>Talicauda nyseus</i>	0	0.16		
185	Common Cerulean- <i>Jamides celeno</i>	0.81	0.93		
186	Metallic Cerulean- <i>Jamides alecto</i>	0.2	0.25	SC II	
187	Glistening Cerulean- <i>Jamides elpis</i>	0.1	0.08		Endemic
188	Dark Cerulean- <i>Jamides bochus</i>	0.3	0.08		
189	Forget-me-Not- <i>Catochrysops strabo</i>	0.3	0.08		
190	Pea Blue- <i>Lampides boeticus</i>	0.2	0		LC
191	Lime Blue- <i>Chilades lajus</i>	0.6	1.18		
192	Plains Cupid- <i>Chilades pandava</i>	0.4	0.67		
193	Zebra Blue- <i>Leptotes plinius</i>	0.3	0.42		
194	Pale Grass Blue- <i>Pseudozizeeria maha</i>	1.21	0.67		
195	Lesser Grass Blue- <i>Zizina otis</i>	0.91	0.93		LC
196	Dark Grass Blue- <i>Zizeeria karsandra</i>	0.2	0.25		
197	Common Quaker- <i>Neopithecops zalmora</i>	0.3	0.5		
198	Malayan- <i>Megisba malaya</i>	0.2	0.08	SC II	
199	Common Hedge Blue- <i>Acytolepis puspa</i>	0.3	0.25		
200	Plain Hedge Blue- <i>Celastrina lavendularis</i>	0.2	0.08		
201	Purple Sapphire- <i>Heliophorus epicles</i>	0.81	0.5		
202	Centaur Oakblue- <i>Arhopala centaurus</i>	1.41	0.84		
203	Sylhet Oakblue- <i>Arhopala silhetensis</i>	0.1	0.25	SC II	Endemic
204	Large Oakblue- <i>Arhopala amantes</i>	0.3	0.08		
205	Luster Oakblue- <i>Arhopala khamti</i>	0	0.16		
206	Yellow-disc Tailless Oakblue- <i>Arhopala perimuta</i>	0.1	0.16		Endemic
207	Aberrant Oakblue- <i>Arhopala abseus</i>	0	0.08		
208	Spotless Oakblue- <i>Arhopala fulla</i>	0	0.16	SC II	Endemic
209	Indian Oakblue- <i>Arhopala atrax</i>	0.2	0		
210	Falcate Oakblue- <i>Mahathala ameria</i>	0.1	0	SC II	
211	Common Acacia Blue- <i>Surendra quercetorum</i>	1.21	0.84		
212	Silver-Streaked Acacia Blue- <i>Zinaspa todara</i>	0	0.16	SC II	
213	Silverstreak Blue- <i>Iraota timoleon</i>	0.1	0.08		
214	Common Tinsel- <i>Catapaecilma major</i>	0	0.08	SC II	
215	Silver Royal- <i>Ancema blanka</i>	0	0.08	SC II	
216	Chocolate Royal- <i>Remelana jangala</i>	0.3	0.5	SC II	
217	Broad-tail Royal- <i>Creon cleobis</i>	0.1	0		
218	Mandarin Blue- <i>Charana mandarinus</i>	0	0.16		
219	Common Tit- <i>Hypolycaena erylus</i>	1.31	1.6		
220	Fluffy Tit- <i>Zeltus amasa</i>	0.3	0.33		

Table 2 Contd..

221	Orchid Tit- <i>Hypolycaena othona</i>	0.3	0.25	SC I	
222	Yamfly- <i>Loxura atymnus</i>	0.5	0.5		
223	Branded Yamfly- <i>Yasoda tripunctata</i>	0	0.16	SC II	Endemic
224	Common Onyx- <i>Horaga onyx</i>	0.2	0		
225	Common Imperial- <i>Cheritra freja</i>	0.4	0.42		LC
226	Blue Imperial- <i>Ticherra acte</i>	0.1	0.16		
227	Common Guava Blue- <i>Virachola isocrates</i>	0.1	0.08		
228	Plane- <i>Bindahara phocides</i>	0.2	0	SC II	
229	Narrow Spark- <i>Sinthusa nasaka</i>	0	0.08	SC II	Endemic
230	Common Red Flash- <i>Rapala iarbus</i>	0.3	0.25		
231	Indigo Flash- <i>Rapala varuna</i>	0.1	0.08	SC II	
232	Copper Flash- <i>Rapala pheretima</i>	0.1	0.16		
233	Slate Flash- <i>Rapala manea</i>	0.2	0.33		
234	Common Flash- <i>Rapala nissa</i>	0.2	0		
235	Branded Flash- <i>Rapala tara</i>	0.2	0		
236	Suffused Flash- <i>Rapala suffusa</i>	0	0.16		
237	Family: Riodinidae	1.11	1.86		
	Punchinello- <i>Zemerus flegyas</i>				
238	Double-Banded Judy- <i>Abisara bifasciata</i>	0.1	0.08		
239	Tailed Judy- <i>Abisara neophron</i>	0.1	0.16		Endemic
240	Family: HesperIIDae	0	0.08		
	Orange Awlet- <i>Burara harisa</i>				
241	Branded Orange Awlet- <i>Burara oedipodea</i>	0.1	0.25		
242	Pale Green Awlet- <i>Burara gomata</i>	0.2	0.08		
243	Orange Tail Awl- <i>Bibasis sena</i>	0.1	0.16	SC II	
244	Common Awl- <i>Hasora badra</i>	0.2	0		
245	Common Banded Awl- <i>Hasora chromus</i>	0	0.16		
246	Brown Awl- <i>Badamia exclamationis</i>	0.2	0		
247	Indian Awlking- <i>Choaspes benjaminii</i>	0	0.08		
248	Pale Striped Dawnfly- <i>Capila zennara</i>	0	0.08		Endemic
249	Tri-Coloured Flat- <i>Coladenia indrani</i>	0	0.16		
250	Common Snow Flat- <i>Tagiades japetus</i>	0.5	0.5		
251	Suffused Snow Flat- <i>Tagiades gana</i>	0.3	0.08		
252	Water Snow Flat- <i>Tagiades litigiosa</i>	0.4	0.16		
253	Yellow Flat- <i>Mooreana trichoneura</i>	0	0.08		Endemic
254	Yellow-breasted Flat- <i>Gerosis bhagava</i>	0	0.16		
255	Chestnut Angle- <i>Odontoptilum angulatum</i>	0.1	0.25		
256	Fulvous Pied Flat- <i>Pseudocoladenia dan</i>	0.4	0.59		
257	Common Small Flat- <i>Sarangesa dasahara</i>	0.2	0.25		
258	Restricted Spotted Flat- <i>Celaenorrhinus putra</i>	0.1	0		
259	Indian Grizzled Skipper- <i>Spialia galba</i>	0.2	0.08		
260	Forest Hopper- <i>Astictopterus jama</i>	0.3	0.33		
261	Bush Hopper- <i>Ampittia dioscorides</i>	0.4	0.25		
262	Tiger Hopper- <i>Ampittia subvittatus</i>	0.1	0.25		Endemic
263	Pygmy Scrub Hopper- <i>Aeromachus pygmaeus</i>	0.1	0		
264	Light Straw Ace- <i>Pithauria stramineipennis</i>	0.1	0.25		Endemic
265	Northern Spotted Ace- <i>Thoressa cerata</i>	0.3	0		Endemic
266	Banded Ace- <i>Halpe zema</i>	0.7	0.33		Endemic
267	Moore's Banded Ace- <i>Halpe porus</i>	0.2	0.08		
268	Gold-Spotted Ace- <i>Halpe aucma</i>	0.3	0		
269	Tufted Ace- <i>Sebastonyma dolopia</i>	0.1	0.08		Endemic
270	Yellow-veined Lancer- <i>Pyroneura margherita</i>	0	0.08		Endemic
271	Indian Palm Bob- <i>Suastus gremius</i>	0.3	0.25		
272	Small Palm Bob- <i>Suastus minuta</i>	0	0.08		
273	Chestnut Bob- <i>Iambrix salsala</i>	0.3	0.42		
274	Atkinson's Bob- <i>Arnetta atkinsoni</i>	0.3	0.5		
275	One-spotted Forest Bob- <i>Scobura phiditia</i>	0.1	0.08		Endemic

Table 2 Contd..

276	Extra Forest Bob- <i>Scobura cephal</i>	0.2	0.08	Endemic
277	Large Forest Hopper- <i>Scobura cephaloides</i>	0.2	0.08	Endemic
278	Coon- <i>Psolos fuligo</i>	0.3	0.33	
279	Common Banded Demon- <i>Notocrypta paralysos</i>	0	0.16	
280	Restricted Demon- <i>Notocrypta curvifascia</i>	0.2	0.25	
281	Chocolate Demon- <i>Ancistroides nigrita</i>	0.4	0.5	
282	Grass Demon- <i>Udaspes folus</i>	0.81	0.42	
283	Wax Dart- <i>Cupitha purreea</i>	0.3	0.16	
284	Tree Flitter- <i>Hyarotis adrastus</i>	0.2	0.08	
285	Purple-and-gold Flitter- <i>Zographetus satwa</i>	0	0.16	
286	Multi-spotted Flitter- <i>Isma bonota</i>	0	0.16	
287	Green-striped Palmer- <i>Pirdana major</i>	0	0.08	
288	Giant Redeye- <i>Gangara thyrasis</i>	0	0.16	
289	Palm Redeye- <i>Erionota thrax</i>	0.1	0	
290	Common Redeye- <i>Matapa aria</i>	0.3	0.42	
291	Black Veined Branded Redeye- <i>Matapa sasivarna</i>	0.2	0.08	
292	Grey-Branded Redeye- <i>Matapa druna</i>	0.2	0	
293	Fringed Redeye- <i>Matapa cresta</i>	0	0.25	
294	Swift Butterfly- <i>Parnara sp.</i>	0.2	0.33	
295	Great Swift- <i>Pelopidas assamensis</i>	0.1	0	
296	Obscure Banded Swift- <i>Pelopidas agna</i>	0.2	0.16	
297	Small Paint-brush Swift- <i>Baoris chapmani</i>	0.2	0	Endemic
298	Paintbrush Swift- <i>Baoris farri</i>	0	0.25	
299	Black Paint-brush Swift- <i>Baoris unicolor</i>	0	0.08	
300	Caltoris Swifts- <i>Caltoris sp.</i>	0.3	0.08	
301	Common Wight- <i>Iton semamora</i>	0.2	0.08	
302	Common Dartlet- <i>Oriens gola</i>	0.2	0.08	
303	Indian Dartlet- <i>Oriens goloides</i>	0	0.08	
304	Dart Butterfly- <i>Potanthus sp.</i>	0	0.08	
305	Plain Palm-Dart- <i>Cephrenes acalle</i>	0.2	0	
306	Palm Dart- <i>Telicota sp.</i>	0.2	0.16	

The study also stated that the Garbhanga Reserve Forest has the highest number of butterflies than the Rani Reserve Forest (Figure 2). Riparian fringe forest was the most used habitat with 185 species, Human habitation with 140 species, short grassland with 130 species, Mixed deciduous forest with 123 species, Agricultural land with 51 species, Secondary Forest with 48 species, and least used habitat was the Bamboo brakes with 42 species. The higher use of riparian fringe areas and human land could be due to the suitable habitat for mud-puddling and the abundance of a large number of nectar-feeding plants and larval host plants as well. Ghosh & Saha (2016) said that water resources encourage adult butterflies to mud puddle in large congregations on the sandy patches along the streams, which results in high diversity of butterflies in this habitat. Lesser use of agricultural land, secondary forest and bamboo brakes might be because of the unavailability of nectar and host plants, and also due to a lack of puddling ground. Use of pesticides in the agricultural field, and the anthropogenic disturbances like deforestation, could have contributed to less species richness and diversity of butterflies in these habitats. Our finding contradicts the findings of Choi & Kim (2012), who reported that butterflies are mostly found in grassland habitats. According to Ghose

& Saha (2016), pesticide use, grazing pressure and changes in land use patterns harm the butterfly population. Ghose & Saha (2016) found that water resources encourage adult butterflies to mud puddle in large congregations on the sandy patches along the streams, which results in high diversity of butterflies in this habitat.

The members of Papilionidae and Riodinidae butterflies don't use the habitat of Bamboo brakes. On the other hand, families Nymphalidae, Lycaenidae and Hesperidae used all seven types of habitats, but family Riodinidae used only Riparian fringe forest, short grassland, Mixed deciduous forest and Secondary Forest habitat type (Figure 4).

The species richness and diversity of butterflies in Garbhanga and Rani Reserve Forest are influenced by various factors, as these forests are connected with the Jarasal-Kwasing Reserve, Nakhalliyang Wildlife Sanctuary, and Jirang Unclassed State Forest of the neighbouring state of Meghalaya, which together affect the distribution pattern of butterflies.

Barua *et al.* (2004) reported 29 species of swallowtail butterflies from Garbhanga forest, whereas the present study recorded 27 species of swallowtails only. This slight variation in species richness could be

influenced by several factors, including climate change, seasonal fluctuations, and varying anthropogenic pressures, such as habitat fragmentation, agricultural expansion, and increased human disturbances over the years may have contributed to population declines or range shifts of certain species. Moreover, swallowtail butterflies are known for their pronounced seasonal abundance patterns, which could also explain the differences observed between the two studies. On the other hand, Modak *et al.* (2018) published a paper on butterfly diversity in Garbhanga Reserve Forest that contains several inaccuracies. For instance, they reported *Arnetta mercara*, a South Indian species; *Charaxes protoctlea*, an African species; *Heliconius erato*, a neotropical species; and several other species which are not even found in India. More recently, Dutta *et al.* (2025) published a study from the IIT Guwahati Campus that also contains multiple errors, including misidentifications of common butterfly species, inclusion of species absent from the region, and an erroneous attribution of *Dryas iulia*, a species native to the Americas (Lamas, 2004). Although *Dryas iulia* was not listed in their checklist, its image was used and labelled as *Appias galba*, a significant taxonomic and scientific error. They also reported *Meandrusa payeni*, (not reported from Assam to date); *Appias galba*, which is known only from Barak Valley and Golaghat districts, with no records from Lower Assam. The butterfly fauna of Garbhanga and Rani Reserve Forest has already proved to be an exceptionally valuable conservation asset: 71 species among the recorded 306 species of butterflies, or 22.87% are legally protected under the Indian Wildlife Protection Amendment (Act), 2022 (Table 2). Therefore, the reserve forests not only have a high diversity of butterflies but also support a large number of rare, endemic and legally protected species. Sightings of some rare, endemic and exclusive species such as *Elymnias peali*, *Zipaetis scylax*, *Stichopthalma camadeva*, *Pyronura margherita* show the importance of conserving Garbhanga and Rani Reserve Forests as the study area supported 52 species of endemic butterflies. So, the recorded number of butterflies may be useful in comparative studies of Rani-Garbhangha Reserve Forest landscape changes in the face of the ongoing expansion of the human population and the associated growth of agriculture, mining, and other developmental activities.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this paper.

AUTHOR'S CONTRIBUTION

The authors confirm their contributions to this paper as follows: MKT: Literature review, data collection, data compilation, data analysis, manuscript writing, and manuscript drafting; MKS: Conceptualization, guiding the research, study design, and overall supervision; PKS: Data validation, data organization, and manuscript proofreading. All authors read and approved the final manuscript.

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