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Species diversity of butterflies in Gaya district (Bihar), India*Mohammad Danish Masroor¹, Zakkia Masroor², Abhishek Kumar (I.F.S.)³*¹P. G. Department of Zoology, Magadh University, Bodhgaya, Narhat, Nawada, Bihar, 805122
India²Dr. B. R. Ambedkar College of Education, Bodhgaya, Narhat, Nawada, Bihar, 805122, India³Divisional Forest Officer, Gaya Forest Division, Shanti Bagh, Kareem Ganj, Gaya, 823001*Corresponding author: mohammaddanishmasroor@gmail.com***Abstract**

Seventy-two species of butterflies belonging to five families were recorded for first time from Gaya district. Six sites were selected post pilot survey on the basis of both, nectar and larval host plant richness, diversity and anthropogenic pressure along with road connectivity. The maximum species diversity and richness was observed in winter season, while minimum in summer season. Plain tiger, Common jezebel, Common crow, Common castor, Tawny castor, Common emigrant, Peacock pansy, Grey pansy, Chocolate pansy, Common Pierrot, Lime blue, Great eggfly, Common grass yellow, Common sailor, Common evening brown and Small branded swift were dominant butterfly species in all selected sites while Common silverline, Indian sunbeam and Apefly were rare. Pollution due to dust, vehicular movements and activities like damaging nectar and larval host plant during breeding season, in and around habitats, due to lack of information seems to adversely effect the species diversity and population density in the region.

Key words: - Butterfly, Species diversity, Gaya, Bihar.**Introduction**

Butterflies, the delicate and colorful creatures play an important role in ecosystem indication and as a food source for many species in food chain. The species diversity and butterflies association with flora reflects the persistence of population and ecological stability of the butterflies. They serve an important role as ecological indicator for habitat degradation and modification due to an intimate relation with their native habitat. In

the developmental biology of butterflies including larval and adult stages, multi-dimensional factors like larval host plants, adult nectar plants, habitat and safety from the predators are ecologically different (Gilbert, 1984). Due to a complex relation with the environment and critical relation among required food plants, predators and parasitoids, butterflies explore multiple situations within their life cycle. India is a country having a mega-diversity of insect fauna and representing 1504 species diversity of

butterflies known till date (Kunte *et al.* 2012). While 285 species of butterflies are found in southern India and 64 species reported from Rajgir, Bihar. In the context of Magadh division no data is available till now. In recent years, use of pesticides, climate change and deforestation are causing habitat loss and decline in butterfly populations. According to a report compiled by Mongabay during 2001-2018, India lost 1, 625, 97 hectare of tree cover which is 19.1% of total tree covering area (Mongabay India, 2018/02). Food and Agriculture Organization also reported that about 35 percent of pollinators and about 17% of vertebrate are facing extinction globally (Mongabay India, 2022/12). Butterflies being highly sensitive in their nature require special ecological condition for reproduction and survival. The ecologically typical butterfly habitats include grasslands, plant canopies, semi-wild, forest and bank of rivers.

Gaya (in Bihar) is situated at 24°47' N latitude and 85°98' E longitude and has a warm and temperate climate. It has an area of 308 Km² and population of 4.71 lakh. Mainly the vegetation consists of deciduous and thorny forests. The geographical land cover of Gaya is influenced by multiple hills and elevations like Brahmyoni hill, Katari hill, Ramsila hill, Pretsila hill and Murli hill. Along with the hills, Falgu River is also an historical as well as ecological factor which provides large area covered by grasslands at the edge of river providing a favorable habitat for the butterfly species diversity.

However, various reasons have altered the butterfly habitats like human intervention and deforestation. As a result of this alteration some species are on the verge of extinction and if a single species is extinct, it will push multiple related species also on the path of extinction. The need of butterfly conservation is therefore demand of the hour. For the conservation, the information and data regarding their species diversity, status and factors affecting their population and survival is preliminary requirement for forecasting the need of conservation for those species butterflies whose population are declining.

Material and Methods

Survey method

The species diversity of butterflies was surveyed by simple random method for a period of two-years from August 2019 to November 2021. The number of butterflies was counted arbitrarily in a range of 15 feet in the early morning to afternoon hours weekly. The path of observation was specific and fixed in time and movement patterns. The survey was conducted in good weather and extreme hot and rainy weather were not taken as a part of survey. To study species diversity of the butterflies in Gaya district the photographic identification method was used by the authors. The photographs were taken from their natural habitats with the help of Galaxy J7 Max Tab for identification. The photographs were taken in GPS enabled mode in their respective survey during consequent months.

Survey site

Random survey method was used to select important sites for observation and after those six different sites with the abundance of nectar and larval host plants along with anthropogenic pressure was selected for the further observation. These were (SITE 1) Magadh University campus, (SITE 2) JaiPrakash park Bodhgaya, (SITE 3) Katari Hill, (SITE 4) Brahamyoni Hill, (SITE 5) Pretshila Hill and (SITE 6) Ramshila Hill were selected as important sites for the study.

Site: - 1. Magadh University Campus & **Site: - 2.** Jai Prakash Park, Bodhgaya & **Site: - 4.** Brahamyoni Hill: - Selected due to abundance of nectar, larval host plant and less anthropogenic pressure.

Site: - 3. Katari Hill, **Site: - 5.** Pretshila Hill & **Site: - 6.** Ramshila Hill: - Selected due to a smaller number of nectar plants, larval host plants and high anthropogenic pressure like regular human conflict, dust laden plants.

Identification of species diversity

The color photographs were used for the identification procedure of butterflies. The coloration of body, wing patterns, wing design and other outer morphological features of identification were compared for identification of butterfly species with the help of relevant literatures i.e., Bingham, 1905 and 1917, Evans, 1932, Kehimkar, 2008, Gupta and Majumdar, 2012, Gajbe, 2016, Kumar, 2016,

Sharma and Kumar 2017, Sondhi and Kunte, 2018, Ghatak and Roy, 2013 and Kumar and Sharma 2021.

Results and Discussion

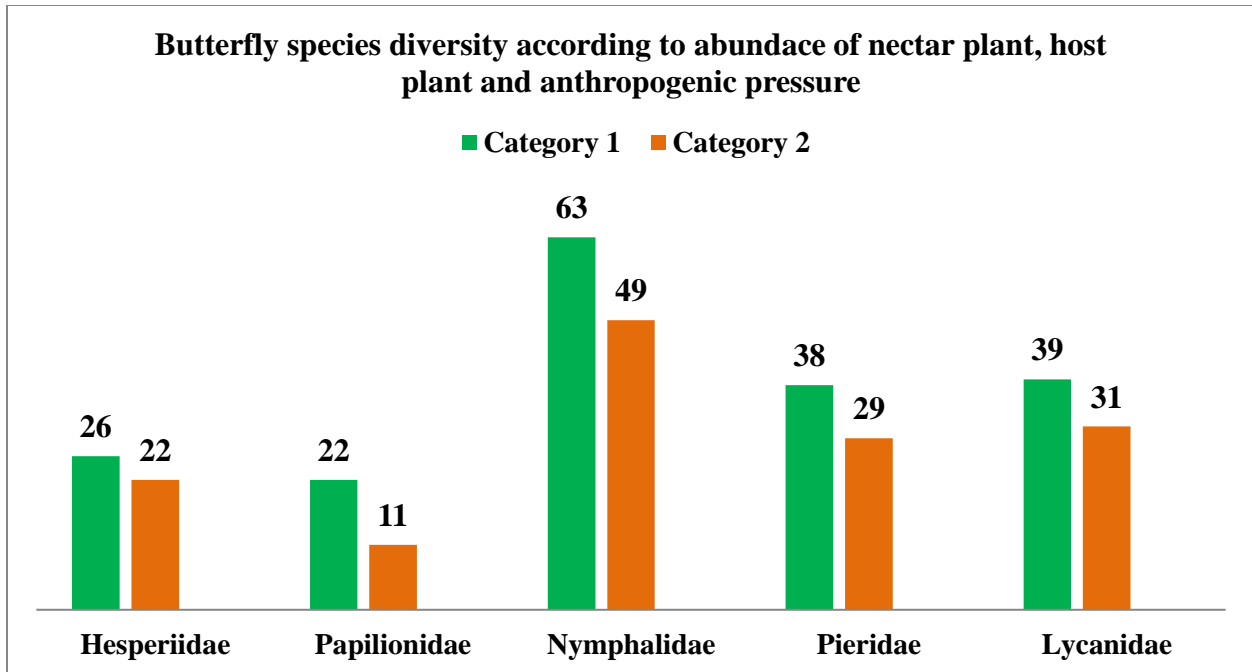
A total of seventy-two species including two sub-species of butterflies were reported during first time documentation of butterflies in Gaya district (Table 1). Twenty-two species belonging to Nymphalidae (30.5%), seventeen species of Lycaenidae (23.7%), fourteen species of Pieridae (19.4%), ten species of Hesperidae (13.8%) and nine species of Papilionidae (12.6%) were observed (Histogram 1 & 2). Seventy-two species of butterflies were observed in site 1, fifty-five in site 2, forty-two in site 3, sixty-two in site 4, forty-nine in site 5 and forty in site 6. Nymphalidae family was observed in maximum number among all families. Maximum number of Blue tiger butterfly was observed in site 1 while maximum number of Common leopard butterfly was observed in site 4. In view of anthropogenic pressure Common castor and Plain tiger butterfly was observed in maximum numbers at the places under anthropogenic pressure. In the places where nectar and larval host plants were low in diversity, the butterfly diversity was low in comparison to where nectar and larval host plant was abundant and not in under anthropogenic pressure. The statistical analysis of correlation between category 1 (Abundance of nectar and larval host plant with less anthropogenic pressure) and category 2 (High anthropogenic pressure and smaller

number of nectar and larval host plant) shows significant result at $p < 0.05$, while calculated mean of category 1 was 37.6 and of category 2 was 28.4, Pearson (r) was 0.979 and P-Value is 0.003642 which indicates strong positive correlation between both categories. The results are indicative that area with abundance of nectar plants and larval host plants under less anthropogenic pressure represents more species than the area having high anthropogenic pressure along with less nectar and host plants. Larvae or pupae not been observed on plants laden with dust particles near construction sites or continuous movement of vehicles act as anthropogenic

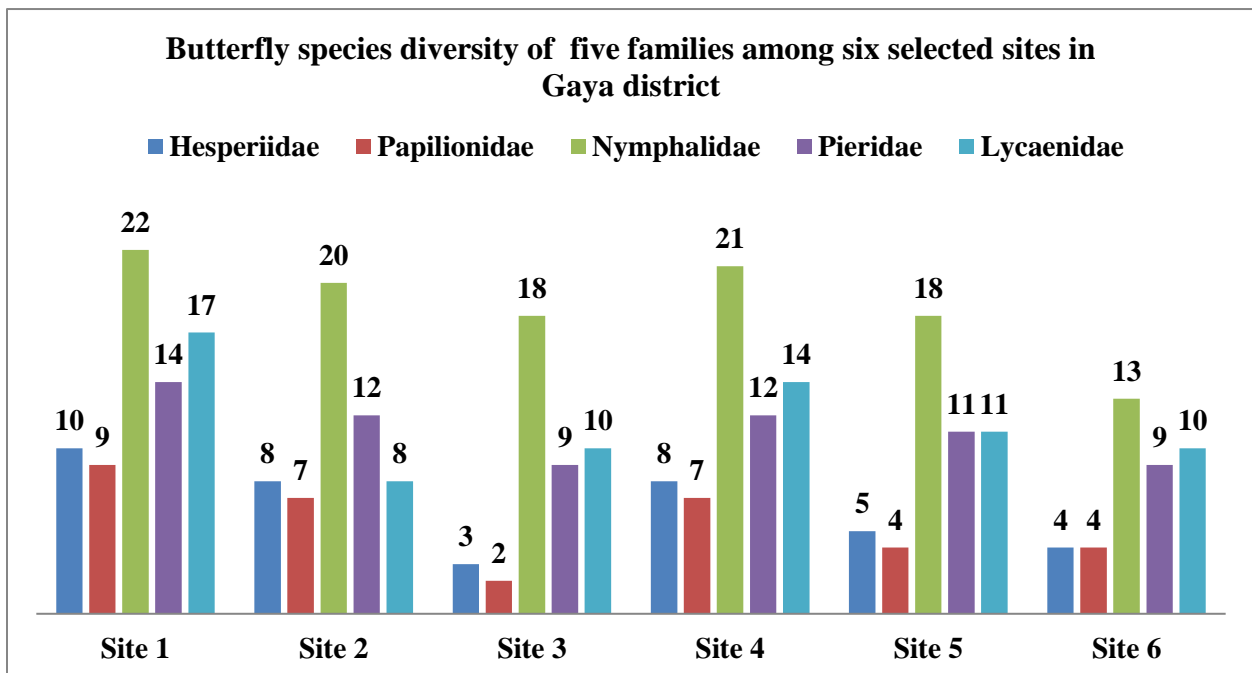
pressures. A detailed study will be needed for exploring complete species biodiversity and population density at a micro habitat level and to understand the adaptation mechanism by butterflies under anthropogenic pressure in Gaya region.

Some unusual observations

Common emigrant and Common crow were observed preparing chrysalis on Milkweed plant. Hundreds of Common evening brown were found foraging during evening hours on rotten fruits of *Ficus* in J. P. Park.



Histogram 1. Number of butterfly species belonging to each family observed during study.



Histogram 2. Graph showing butterfly species diversity of five families in six selected sites of Gaya district.

Table 1. List of butterfly species observed around six selected sites in Gaya district during August 2021- October 2021

Sl. No.	Common name	Scientific name	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
	Family: Hesperiiidae							
1	Indian Palm Bob	<i>Saustus grenius</i> (Fabricius, 1798)	*	*		*	*	
2	Small Branded Swift	<i>Pelopidas mathias</i> (Fabricius 1798)	*	*	*	*	*	*
3	Common Red Eye	<i>Matapa aria</i> (Moore, 1866)	*	*				
4	Paint Brush Swift	<i>Baoris farri</i> (Moore, 1878)	*	*		*		
5	Grass Demon	<i>Udaspes folus</i> (Cramer, 1775)	*	*		*		*
6	Contiguous Swift	<i>Polytremis lubricans</i> (Herrich-Schaffer, 1869)	*	*		*		
7	Rice Swift	<i>Barbo cinnara</i> (Wallace, 1866)	*				*	*
8	Dark Palm Dart	<i>Telicota bambusae</i> (Moore, 1878)	*	*	*	*	*	*
9	Asian Grizzled Skipper	<i>Spialia galba</i> (Fabricius, 1793)	*		*	*		
10	Common Palm Dart	<i>Telicota colon</i> (Fabricius, 1775)	*	*		*	*	
	Family: Papilionidae							
11	Common Mormon	<i>Papilio polytes</i> (Linnaeus, 1758)	*	*	*	*	*	*
12	Indian Common Mormon	<i>Papilio polytes romulus</i> Cramer, 1775	*	*		*	*	
13	Lime Butterfly	<i>Papilio demolus</i> (Linnaeus, 1758)	*	*		*		*
14	Common Jay	<i>Graphium doson</i> (C. & R. Fedler, 1864)	*	*	*		*	
15	Tailed Jay	<i>Graphium agramemnon</i> (Linnaeus, 1758)	*	*		*		*
16	Common Rose	<i>Pachliopta aristolochiae</i> (Fabricius, 1775)	*			*		
17	Common Mime	<i>Papilio clytia</i> Linnaeus, 1758	*			*	*	*
18	Blue Mormon	<i>Papilio polymnestor</i> (Cramer, 1775)	*	*		*		
19	Crimson Rose	<i>Pachliopta hector</i> (Linnaeus, 1758)	*	*				
	Family: Nymphalidae							
20	Gray Pansy	<i>Junonia atlites</i> (Linnaeus, 1763)	*	*	*	*	*	*
21	Peacock Pansy	<i>Junonia almana</i> (Linnaeus, 1758)	*	*	*	*	*	*
22	Chocolate Pansy	<i>Junonia iphita</i> (Cramer, 1779)	*	*	*	*	*	*
23	Lemon Pansy	<i>Junonia lemonias</i> (Linnaeus, 1758)	*	*	*	*	*	*
24	Yellow Pansy	<i>Junonia hierta</i> (Fabricius, 1798)	*	*			*	
25	Blue Pansy	<i>Junonia orithya</i> (Linnaeus, 1758)	*	*	*	*	*	
26	Plain Tiger	<i>Danus chrysippus</i> (Linnaeus, 1758)	*	*	*	*	*	*
27	Striped Tiger	<i>Danus genutia</i> (Cramer, 1779)	*	*		*	*	
28	Blue Tiger	<i>Trimula limniace</i> (Cramer, 1775)	*	*	*	*		*
29	Common Baron	<i>Euthalia aconthea</i> (Cramer, 1777)	*	*		*	*	
30	Common Leopard	<i>Phalanta phalanta</i> (Drury, 1773)	*		*	*		
31	Common Crow	<i>Euuploea core</i> (Cramer, 1780)	*	*	*	*	*	*
32	Common Evening Brown	<i>Melantis leda</i> (Linnaeus, 1758)	*	*	*	*	*	*
33	Common Four-ring	<i>Ypthima huebneri</i> Kirby, 1871	*		*	*		

Sl. No.	Common name	Scientific name	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
34	Common Bush Brown	<i>Mycalesis perseus</i> (Fabricius,1775)	*	*	*	*	*	
35	Commander	<i>Moduza procris</i> (Cramer,1777)	*	*		*	*	*
36	Great Eggfly	<i>Hypolimnas bolina</i> (Linnaeus,1758)	*	*	*	*	*	*
37	Danaid Eggfly	<i>Hypolimnas misippus</i> (Linnaeus, 1764)	*	*	*	*	*	*
38	Common Castor	<i>Ariadne merione</i> (Cramer, 1777)	*	*	*	*	*	*
39	Tawny Castor	<i>Acraea terpsicore</i> (Fabricius,1793)	*	*	*	*	*	*
40	Common Sailor	<i>Neptis hylas</i> (Linnaeus, 1758)	*	*	*	*	*	
41	Common Palmfly	<i>Elymnias hypermnestra</i> (Linnaeus, 1763)	*	*	*	*		
	Family: Pieridae							
42	Mottled Emigrant	<i>Catopsilia pyranthe</i> (Linnaeus,1758)	*	*	*	*	*	
43	Common Emigrant	<i>Catopsilia pomana</i> (Fabricius, 1775)	*	*	*	*	*	*
44	Oriental Mottled Emigrant	<i>Catopsilia pyranthe pyranthe</i>	*	*				
45	Yellow Orange Tip	<i>Ixias pyrene</i> Linnaeus, 1764	*	*	*	*		*
46	White Orange Tip	<i>Ixias Marianne</i> (Cramer,1779)	*			*	*	
47	Common Jezebel	<i>Delias eucharis</i> (Drury,1773)	*	*	*	*	*	*
48	Common Wanderer	<i>Pareronia hippia</i> (Cramer,1776)	*	*		*	*	
49	Common Grass Yellow	<i>Eurema hesabe</i> (Linnaeus,1758)	*	*	*	*	*	*
50	Spotless Grass Yellow	<i>Eurema laeta</i> (Boisduval,1836)	*	*	*	*	*	*
51	Lesser Gull	<i>Cepora nadia</i> (Lucas, 1852)	*					*
52	Common Gull	<i>Cepora nerissa</i> (Fabricius,1775)	*	*	*	*	*	
53	Indian Cabbage White	<i>Pieris canidia</i> (Sparrman, 1768)	*	*		*	*	*
54	Small Grass Yellow	<i>Eurema brigitta</i> (Stoll, [1780])	*	*	*	*	*	*
55	Psyche	<i>Leptosia nina</i> (Fabricius,1793)	*	*	*	*	*	*
	Family: Lycaenidae							
56	Common Pierrot	<i>Castalius rosimon</i> (Fabricius,1775)	*	*	*	*	*	*
57	Common Silverline	<i>Cigaritis vulcanus</i> (Fabricius,1775)	*				*	
58	Plains Cupid	<i>Chilades pandava</i> (Horsefield,1829)	*	*	*	*	*	*
59	Slate Flash	<i>Rapala manea</i> (Hewitson,1863)	*		*	*	*	
60	Dark Grass Blue	<i>Zizeeria karsamdara</i> (Moore,1865)	*	*	*	*	*	*
61	Lesser Grass Blue	<i>Zizina otis</i> (Fabricius,1787)	*	*	*	*	*	*
62	Rounded Pierrot	<i>Tarucus nara</i> (Kollar,1884)	*	*	*	*	*	*
63	Common Guava Blue	<i>Virachola isocrates</i> (Fabricius,1793)	*			*		
64	Lime Blue	<i>Chilades lajus</i> (Stoll, [1780])	*	*	*	*	*	*
65	Gram Blue	<i>Euchysops cnejus</i> (Fabricius,1798)	*	*	*	*	*	*
66	African Babul Blue	<i>Azonus jesous</i> (Guerin-Meneville,1849)	*			*		
67	Pea Blue	<i>Lampidus boeticus</i> (Linnaeus,1767)	*	*	*	*	*	*
68	Ape fly	<i>Spalgis epeus</i> (Westwood, 1851)	*					*
69	India Sunbeam	<i>Curetis thetis</i> (Drury, [1773])	*			*		*
70	Saronis Sunbeam	<i>Curetis saronis</i> Moore,1877	*		*			
71	Spotted Pierrot	<i>Taucus callinara</i> Butler,1886	*			*	*	
72	Margined Hedge Blue	<i>Celatoxia marginata</i> (de Niceville, [1884])	*			*		

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