Assessment of Butterfly (Lepidoptera: Rhopalocera) Diversity and Relative Abundance in Rivona Near the Foothills of Western Ghats-Goa

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ABSTRACT

Investigation on Butterfly diversity in Rivona near the foothills of Western Ghats in Goa was carried out at four different sites namely forest, river side, Paddy field and temple areas from August to December, 2019. The four sites have shown rich diversity of butterfly population, however variations of species diversity observed in different sites. 62 species belonging to 44 genera have been recorded at Rivona. The Nymphalidae showed the maximum relative abundance in terms of percentage of observed species (43.67%), followed by Papilionidae (15.82%), Lycaenidae (15.18%), Pieridae (13.92%), Hesperiidae (10.12%) and Riodinidae (01.26%). Increased anthropogenic activities such as gradual expansion of areas under inhabitancy, ecotourism, increased cultivation of crops and other agro based activities, application of chemical fertilizers, pesticides, transport of mining ore reflected in the decreased diversity of butterfly population in the two field stations namely temple and paddy field, out of four areas under the present investigation at Rivona.

Keywords: Biodiversity, Butterfly, Lepidoptera, Rivona, Western Ghats

INTRODUCTION

Butterfly diversity is not evenly distributed in the world. Species diversity is an indication of biological diversity in a specific ecological community. Butterflies play a crucial role in ecosystem functions. Co evolutionary relationship is reported between plants and butterflies (Ghazanfar et al, 2016), In nature they play a significant role in pollination (Webb, 2008; Shi et al., 2009; Johannes et al., 2011). They help in controlling the number of plants and insect population (Conrad et al., 2007). Butterflies and plants lives are exceptionally interlinked, which leads to different patterns in their distribution depending on the availability of their food plants (Feltwell, 1986; Burghardt et al., 2009; Vina, and Liu, 2017).

Food and feeding mechanisms are most essential factors, affecting biological diversity of animals. This is most applicable to butterfly as food and mode of feeding are different in the larval and adult stages (Kunte, 2000). It is found that any minor change in their natural habitat due to anthropogenic factors can lead to their migration or local population extinction (Mennechez et al., 2003). They are good biological indicators of habitat quality (Donald et al., 2011; Sawchick et al., 2005) and are very sensible to environmental factors and availability of larval host plants (Ribeiro and Freitas, 2012; Alstad and Andow 1995), Anthropogenic factors including the loss of milkweed resources for larvae due to genetically modified crops, pesticides and fertilizer (Nora et al., 2018), loss of nectar resources from flowering degraded forest habitats due to plants, commercially motivated deforestation and other economic activities have threatening effects, especially on the migrating butterflies like Monarch Butterflies (*Danaus plexippus*). (Malcolm, 2018).Managing the evolution of insect resistance to transgenic plants was reported by (Alstad. and Andow, 1995), considering the potential impact of transgenic crops on nontarget animals, plants and other organisms.

The major biodiversity hotspots of India are the Western Ghats and the Himalayas. Goa forms part of the Western Ghats and falls in transition zone between the northern and southern Western Ghats. Rivona is situated in the Sanguem taluka at about 2 km from Zambaulim, is known for its refreshing springs and verdant beauty, is also known as the cradle of Indian civilization and the abode of the Rishis. The Rivona caves or the Pandava caves are in the forest area outside the village. The Shri Vimleshwar temple is located on the edge of the village near the turnoff for the caves. Present investigation on Butterfly diversity in Rivona, near the foothills of Western Ghats in Goa was carried out from the month of August to December 2019 to analyse the diversity and relative abundance of different butterfly species, since it is blessed with rich biodiversity due to semi evergreen forest and dense vegetation cover.

Though being the smallest state of the country, Goa has endowed with the 215 species of butterflies. (Gaude and Janarthanam, 2015). Borkar and Komarpant, (2004) studied diversity, abundance and habitat associations of butterfly species in Bondla wildlife sanctuary of Goa, India in three distinct habitat types, within the sanctuary viz. forests, orchards and formal gardens and reported 91 butterfly species

belonging to 66 genera, 14 subfamilies and 5 families. Bowalkar et al., (2017) prepared a checklist of butterflies (Insecta: Lepidoptera) from Taleigao plateau Goa, India. Gaude and Janarthanam, (2015) documented the butterfly diversity of four sacred groves of Goa, India. Generally sacred groves being protected have high floral and faunal diversity. They hold a high number of butterflies. Presence of Endemic and Near Threatened species, viz., Southern Birdwing Troides minos and Malabar Tree Nymph Idea malabarica indicates the services of the sacred groves for the butterflies and their conservation. However, no report is available on diversity of butterflies in Rishivan (Rivona) area. Hence, the present study aims to document the diversity of butterfly fauna found in and around the historical village Rivona.

MATERIAL AND METHODS

'RISHIVAN' or the forest of the sages, as Rivona was believed to be known in ancient times, situated on the bank of the serene kushavati river nearby to Netravali wild life sanctuary. Rivona is surrounded by Sanguem towards east, Salcete towards West, Canacona towards South and Quepem towards North. The altitude is 57 meters above the sea level. It has a tropical monsoon climate and generally humid and warm throughout the year. It is situated at 15.1561°North latitude and 74.1064 ° East longitude. The temperature ranges from 20°C-34°C. Lush green forest, cultivated paddy fields, coconut and areca nut groves, fresh water springs and rolling hills describes the landscape of this village.

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Four areas from Rishivan (Rivona) village forest, river, paddy field and temple sites were selected, to collect the inventory data for the butterfly diversity.

Forest site (Addem) is a semi evergreen and moist deciduous forest consisting of Teak, Sal, Cashew, Mango, Jackfruit, Pineapple and Blackberries. It acts as a shelter and food for large number of fauna, living in this forest. River site: (Kushavati) that runs through the village of Rivona, plays an important role in the faunal diversity of the village. A bridge runs over the river in the village which connects Rivona to Addem. Paddy field site (Gaiginim). Paddy is the main agriculture crop in Rivona. It is being cultivated in both Kharif and Rabi seasons. It is surrounded by Kushavati River on one side along with coconut plantation on other side and the temple site (Shri Vimleshwar temple) is located on the edge of the village near the turnoff for the caves. It has paddy fields in its surrounding along with gardens of betel nut and coconut trees.





The survey was conducted from August to December, 2019 as we aimed at reporting diversity in the post monsoon period, on the Sundays, when butterflies were most active i.e. from 8.30 am -12.00 noon. Specimen collection was strictly avoided. Butterflies were photographed using cell phones (Realme 3i, One plus 6, Redmi note 4, Micromax canvas hue and ASUS Z010D) and camera (Nikon d5600 lens 18-55mm).

The Butterflies were grouped into five categories based on their relative abundance status, as per the scheme followed by Tiple, (2012). The five classes are abbreviated as Very Common > 100 (VC), Common between 50-100 (C), Not Rare, 15-50 (NR), Rare between 2-15 (R), Very Rare, 1-2 (VR). This is based on the total number of sightings, a butterfly is reported.

The butterflies were identified with the help of Nature Guides Common Butterflies of India by (Gay *et al.,* 1992); Photographic guide by Rangnekar, (2007); Butterflies of Western Ghats by Kasambe, (2018) and the website www.ifoundbutterflies.org.

The relative abundance of butterflies was calculated using the formula;

Total number of individual species

Relative Abundance = ------ X 100

Total individuals of all the Species recorded.

RESULTS AND DISCUSSION

The abundance of butterfly diversity in different ecosystems is directly proportional to the type and variety of flowers and the number of plants in a particular area (Umapati et al., 2016). The occurrence and peak period of each butterfly species is different. Amongst the 62 recorded species, Common Rose and Common Grass Yellow were regularly found during the survey. (Table.1). Similar results were observed in the Campus of Manonmaniam Sundaranar University, Tamil Nadu, India by Kumar et al., (2017).Common Jezebel is seen from August with peak period of flying in October. Psyche though found throughout our study period was less in abundance than the Common Grass Yellow. The Common Wanderer is seen sporadically during the monsoons and is found to be more active during the months of October and November and falls under the Very Common (VC) category. Chocolate Pansy though present throughout the study period, was less abundant from October onwards.

The Southern Birdwing which is the endemic species according to the IUCN Red list was spotted on five Sundays near the forest site and along the Kushavati river. The Malabar Tree Nymph which is considered as the threatened species was spotted only once in the forest. Both these species are protected under Schedule-I of Wildlife Protection Act 1972.

The Blue Oak leaf was reported twice but was restricted to the monsoon, while Red Helen was also spotted twice in the forest in the post monsoon and winter. (Table.1). Similar observations were reported by Borkar and Komarpant, (2004) in Bondla Wildlife Sanctuary, Goa.

Sr.N	Scientific Name	Common Name	August		September		October		November		December													
о.	Sciencine Hume	connormanic	4	11	10	25	1		15	22	20	6	12	20	27	2	10	17	24	1		15	22	20
	Ampittia diasaaridas	Bush Honner	4	11	10	23	1	•	21	11	9	8	7	20	5	9	10	17	24	12	0	15	22	29
2	Ampritia aloscoriaes	Chestnut Bob				3	6		7	11	22	39	6	Ů	-		10		21	12	2			
2	Lidasnes folus	Grass Demon																з	,		~			
1	Snialia aalba	Indian Skipper	1															5						
	Tagiades litigiosa	Water Snow Flat									1									1				
6	Tagiades agna	Suffused Snow Flat									1									_				
7	Triodes minos	Southern Birdwing									2	2	3					1		4				
	Granhium sarnedon	Common Blue Bottle	2	3																2				
9	Papilio civtia	Common Mime	1	-																_				
		Common Mormon	1	7	3	8	12		7	5	26	9	11					2	1	4				
10	Papilio polytes	Common Mormon	1	′	3	°	. 12	4			20							2	1	4			<u> </u>	
11	Papilio polymnestor	Blue Mormon				1	4		4	9	6	5	2					2						
12	Papilio buddha	Malabar Banded Peacock											1											
13	Papilio helenus	Red Helen									1								1					
	Graphium agamempon	Tailed Jay									8					5		5						
14	orapinam agamennon	r uncu su y									Ű					2		2						
15	Graphium doson	Common Jay																		2				
16	Papilio demoleus	Lime Butterfly									1								2					
17	Eurema hecabe	Common Grass Yellow	26	34	43	54	56	68	64	101	68	51	65	42	30	30	29	20	23	16	12	10	20	14
18	Delias eucharis	Common Jezebel	1	2	3	6	3	1	11	10	20	30	20	10	10	12	12	8	14	7	4	3	5	5
10	Leptosia nina	Psyche	9	1	10	10	0	26	12	19	9	10	10	14	12	16		17	13	2				
19	Cenora perissa	Common Gull					1			10								2						
20	Pareronia valeria	Common Wanderer		1		6	-		3	12	11	11	19	10	6	9		11	9	4				
21	Catonsilia nomona	Common Emigrant				-			-		14	5	8		-	-			3	-				
23	Catopsilia pyranthe	Mottled Emigrant									2	3							-			2	2	
24	Castalius rosimon	Common Pierrot			2			2		8	16	5	5							4		_		
25	Caleta caleta	Angled Pierrot				2	2		2	7										1				
26	Actolepis puspa	Common Hedge Blue	2	3	2		3	14		5			2							2				
20	Discolamna ethion	Banded Blue Pierrot																	1					
28	Tarucus ananda	Dark Pierrot																	1					
29	Talicada nyseus	Red Pierrot										1						1	1					
30	Chilades pandava	Plains Cupid																8	9	6		6	6	
31	Cheritra freia	Common Imperial																1	-			-		
32	Chilades parrhasius	Small Cupid																9						
33	Spalqis epius	Common Apefly																		5				
34	Jamides celeno	Common Cerulean																	2					
35	Abisara bifasciata	Two Spot Plum Judy				1				2														
26	Melanitis leda	Common Evening										2												
27	Melanitis nhedima	Dark Evening Brown																		1				
20	Orsotrigeng medus	Nigger					5		10	15	6	9	13						3	3				
39	Ypthima huebneri	Common Four Ring				3			9	6	12	36	31					7	11	10	8	11	6	
40	Acraea violae	Tawny Coster		2	2	2		3	2	3	8	3	-						4	2				
41	Cupha ervmanthis	Rustic	1			2														_				
42	Tanaecia lepidea	Grey Count		1					1		4													
43	Euthalia aconthea	Common Baron	8	4	2		8	21		4		9	13					5	3					
	Euploeg core	Common Indian Crow		10	3	9	21	2	12	2.6	45	40	2.7	15	14	1		24	14	4				
44		Common Soilor				-		_				2				-		54	14	-				
45	ivepus liyius	Chartman Star 1, 10, 1										-	-					0	U	4	0	2	-	
46	Neptis jumbah	Chestnut Streaked Saller																		1			<u> </u>	
47	Dolpha evelina	Red Spot Duke	1	-	1			1	1			-											—	
48	Ariadne ariadne	Angled Caster		5	0		5	10		2	11	1	6											
49	Junonia iphita	Chocolate Pansy		9	8	9	10	12	2	3	37		6					6		1				
50	Junonia almana	Feacock Pansy	2	2	2	2	3	/		24	10	23	12					7						-
51	Junonia atlites	Lomon Bongy									10	5	12					9		1				
52	Junonia Iemonias	Denoid Foofly	1		1			2	1		0							1						
53	Hypolimnas haliaa	Great Eggfly		1	1		4	2	1	5	~		-			-		2		1				-
54	Dangus chrisinnus	Plain Tiger		2	4	2	1	6		16			13						2	1				
56	Parantica galea	Glassy Tiger		Ē	<u> </u>	-	<u> </u>		3		15		5					2	2	5	4	2		
57	Danaus genutia	Stripped Tiger									7	5	11					3	2		-	_		
58	Tirumala limniace	Blue Tiger		1									1					2	_					
59	Idea malabarica	Malabar Tree Nymph																	1					
60	Kallima horsefieldi	Blue Oakleaf	1			1																		
61	Lethe europa	Bamboo Tree Brown																		2				
62	Moduza procris	Commander		0																1				
	Total		57	88	86	121	144	165	173	312	381	316	312	99	77	82	51	176	153	113	36	36	39	19

Table 1. Numerical abundance of Butterflies observed during the study Period.

During the survey at four different sites a total of 62 species belonging to 44 different genera under six families were recorded.9 species were found to be very common, 4 common, 14 not rare, 16 rare and 19 very rare. (Table. 2).

				1	r	
Sr.	Family	Scientific Name	Common	Numerical	Relative	Statu
No			Name	Abundance	abundance	S
1	Hesperiidae	Ampittia dioscorides	Bush Hopper	121	3.985	VC
2		Iambrix salsala	Chestnut Bob	103	3.392	VC
3		Udaspes folus	Grass Demon	3	0.098	R
4		Spialia galba	Indian Skipper	1	0.032	VR
5		Tagiades litigiosa	Water Snow Flat	2	0.065	VR
6		Tagiades gana	Suffused Snow Flat	1	0.032	VR
7	Papilionidae	Triodes minos	Southern Birdwing	12	0.395	R
8		Graphium sarpedon	Common Blue Bottle	7	2.307	R
9		Papilio clytia	Common Mime	1	0.032	VR
10		Papilio polytes	Common Mormon	96	3.162	С
11		Papilio polymnestor	Blue Mormon	33	1.086	NR
12		Papilio Buddha	Malabar Banded Peacock	1	0.032	VR
13		Papilio helenus	Red Helen	2	0.065	VR
14		Graphium Agamemnon	Tailed Jay	18	0.592	NR
15		Graphium doson	Common Jay	2	0.065	VR
16		Papilio demoleus	Lime Butterfly	3	0.098	R
17	Pieridae	Eurema hecabe	Common Grass Yellow	876	28.853	VC
18	1	Delias eucharis	Common Jezebel	196	6.455	VC
19		Leptosia nina	Psyche	190	6.258	VC
20		Cepora nerissa	Common Gull	13	0.428	R
21		Pareronia valeria	Common Wanderer	112	0.368	VC

Table 2. Family wise butterflies, common name, scientific name, numerical abundance and relative abundance status.

22		Catopsilia pomona	Common	30	0.988	NR
23	_	Catopsilia pyranthe	Mottled	9	0.296	R
			Emigrant			
24	Lycaenidae	Castalius rosimon	Common Pierrot	42	1.383	NR
25	-	Caleta caleta	Angled	14	0.461	R
			Pierrot			
26		Actolepis puspa	Common Hedge Blue	33	1.086	NR
27		Discolampa ethion	Banded Blue Pierrot	1	0.032	VR
28		Tarucus ananda	Dark Pierrot	1	0.032	VR
29		Talicada nyseus	Red Pierrot	3	0.098	R
30		Chilades pandava	Plains Cupid	35	1.152	NR
31	-	Cheritra freja	Common Imperial	1	0.032	VR
32		Chilades parrhasius	Small Cupid	9	0.296	R
33		Spalgis epius	Common Apefly	5	0.164	R
34	-	Jamides celeno	Common Cerulean	2	0.065	VR
35	Riodinidae	Abisara bifasciata	Two Spot Plum Judy	3	0.098	R
36	Nymphalidae	Melanitis leda	Common Evening Brown	2	0.065	VR
37		Melanitis phedima	Dark Evening Brown	1	0.032	VR
38	-	Orsotriaena medus	Medus brown.	64	2.108	С
39		Ypthima huebneri	Common Four Ring	150	4.940	VC
40		Acraea violae	Tawny Coster	31	1.021	NR
41		Cupha erymanthis	Rustic	3	0.098	R
42]	Tanaecia lepidea	Grey Count	6	0.197	R
43		Euthalia aconthea	Common Baron	77	2.536	С
44		Euploea core	Common Indian Crow	277	9.123	VC
45		Neptis hylas	Common Sailer	28	0.922	NR

46	Neptis jumbah	Chestnut Streaked Sailer	1	0.0329	VR
47	Dolpha evelina	Red Spot Duke	4	0.131	R
48	Ariadne Ariadne	Angled Caster	22	0.724	NR
49	Junonia iphita	Chocolate Pansy	103	3.127	VC
50	Junonia almanac	Peacock Pansy	96	3.162	С
51	Junonia atlites	Grey Pansy	37	1.218	NR
52	Junonia lemonia s	Lemon Pansy	1	0.0329	VR
53	Hypolimnas misippus	Danaid Eggfly	18	0.592	NR
54	Hypolimnas bolina	Great Egg fly	12	0.321	R
55	Danaus chrysippus	Plain Tiger	47	1.257	NR
56	Parantica aglea	Glassy Tiger	38	1.016	NR
57	Danaus genutia	Stripped Tiger	28	0.749	NR
58	Tirumala limniace	Blue Tiger	3	0.080	R
59	Idea malabarica	Malabar Tree Nymph	1	0.026	VR
60	Kallima horsefieldi	Blue Oak leaf	2	0.053	VR
61	Lethe Europa	Bamboo Tree Brown	2	0.053	VR
62	 Moduza procris	Commander	1	0.026	VR
	Total		3036		



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1. Bush Hopper 2.Chestnut Bob 3.Grass Demon 4. Indian Skipper 5.Water Snow Flat 6.Suffused Snow Flat 7.Southern Birdwing 8.Common Blue Bottle 9.Common Mime 10.Common Mormon 11.Blue Mormon 12.Malabar Banded Peacock 13.Red Helen 14.Tailed Jay 15.Common Jay 16.Lime Butterfly 17.Common Grass Yellow 18.Common Jezebel 19.Psyche 20. Common Gull 21. Common Wanderer 22.Common Emigrant 23.Mottled Emigrant 24. Common Pierrot 25.Angled Pierrot



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26.Common Hedge Blue 27.Banded Blue Pierrot 28.Dark Pierrot 29. Red Pierrot 30. Plains Cupid 31.Common Imperial 32.Small Cupid 33.Common Ape fly 34.Common Cerulean 35.Two Spot Plum Judy 36.Common Evening Brown 37.Dark Evening Brown 38.Medus brown 39. Common Four Ring 40. Tawny Coster 41. .CommonPalmfly 42. Rustic 43.Grey Count 44. Common Baron 45.Common Indian Crow 46.Chestnut Streaked Sailer 47. CommonGlider 48. Red Spot Duke 49.Angled Caster 50.Chocolate Pansy



51.Peacock Pansy 52.Lemon Pansy 53. Danaid Egg fly 54.Great Egg fly 55.Plain Tiger 56.Glassy Tiger 57.Stripped Tiger 58.Blue Tiger 59.Malabar Tree Nymph 60. .Blue Oak leaf 61.Bamboo Tree Brown 62.Commander

It is observed that the maximum numerical abundance of 1252 was observed in the forest area with a relative abundance of 41.23% followed by river 905 with a relative abundance

of 29.81% , paddy field 499 with a relative abundance of 16.44 % and least near the temple site with 380 having a relative abundance of 12.52% during the study period (Table.3)

Table 3. Total butterfly abundance at four different sites during the survey period.

Survey Dates	Forest	River	Paddy Field	Temple	Total
04-08-2019	24	18	11	04	057
11-08-2019	30	29	20	09	088
18-08-2019	36	20	22	08	086
25-08-2019	45	41	20	15	121
01-09-2019	58	45	31	10	144
08-09-2019	60	48	30	27	165

15-09-2019	51	51	38	33	173
22 -09-2019	132	76	49	55	312
29-09-2019	175	132	43	31	381
06-10-2019	140	120	36	20	316
13-10-2019	122	93	52	45	312
20-10-2019	42	21	20	16	099
27-10-2019	32	20	13	12	077
03-11-2019	36	22	14	10	082
10-11-2019	25	11	09	06	051
17-11-2019	74	51	27	24	176
24-11-2019	68	40	25	20	153
01-12-2019	53	34	15	11	113
08-12-2019	16	10	05	05	036
15-12-2019	14	08	08	06	036
22-12-2019	12	10	07	10	039
29-12-2019	07	05	04	03	019
Numerical Abundance	1252	905	499	380	3036
Relative Abundance	41.23	29.81	16.44	12.52	

The maximum relative abundance in terms of percentage of observed species belongs to Nymphalidae family was (43.67%) followed by Papilionidae (15.82%), Lycaenidae (15.18%), Pieridae (13.92%) Hesperiidae (10.12%) and Riodinidae (01.26%).(Graph.1)). The reason for the dominance of Nymphalidae may be due to the availability of their larval host plants. This is in good accordance with the observations of (Gaude and Janarthanam, 2015, Umapati *et al.*, 2016)



Graph.1: Occurrence of butterflies of different families at four study sites.

Guptha *et al.*, (2012) explored 50 species of butterflies under five families by photographic documents of Sesha chalam Biosphere Reserve in Eastern Ghats of Andhra Pradesh in India. The families Lycaenidae and Nymphalidae were found to be dominant with 12 species and 20 species respectively

Chandel *et al.*,(2014) photographed 98 butterfly species belonging to 66 genera of five families i.e., Pieridae, Nymphalidae, Papilionidae, Lycaenidae, Hesperiidae from Shivalik hill areas of Kangra and Hamirpur districts of Himachal Pradesh in India

Sheikh and Parey (2019a) reported Six new records of butterflies (Lepidoptera: Insecta) from Jammu and Rajouri Districts of Jammu and Kashmir Himalaya.

Sheikh and Parey (2019b) reported new records of butterflies (Lepidoptera: Insecta) from Jammu and Kashmir Himalaya.

Sheikh, *et al.*, (2021) prepared the Checklist of butterflies (Lepidoptera: Rhopalocera) of Union territory Jammu and Kashmir, India

Gupta and Sheikh reported (2021) First Record of Spotted Small Flat Sarangesa purendra (Moore, 1882) (Lepidoptera: Hesperiidae) from Union Territory of Jammu and Kashmir

Similarly from Jammu and Kashmir Union Territory current literature was reviewed to check the status of similar butterflies and for proper identification purpose (Sheikh *et al.*, 2021; Parey and Sheikh, 2021; Singh and Sheikh, 2021).

In the present investigation highest number of species were observed during post-monsoon

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(September to October) while fewer species were seen during winter (November to December). The occurrence and peak period of each butterfly species is different (Table.3).

Among the Nymphalidae the Rustic, Grey Count, Red Spot Duke, Great Egg fly, Blue Tiger; Southern Birdwing, Common Blue Bottle and Lime Butterfly belonging to family Papilionidae; Two Spot Plum Judy belonging to family Riodinidae; Angled Pierrot, Small Cupid and Common Ape fly belonging to family Lycaenidae; Common Gull and Mottled Emigrant belonging to family Pieridae; and Grass demon belonging to family Hesperiidae all fall under Rare (R) category. The Southern Birdwing which is the endemic species according to the IUCN Red List was spotted on five Sundays near the forest site and along the Kushavati River. The Malabar Tree Nymph which is considered as the threatened species was spotted only once in the forest. Both these species are protected under Schedule-I of the Wildlife Protection Act 1972. Red Helen was spotted only twice in the forest in the post-monsoon and winter, while the Blue Oak leaf was also reported twice but was restricted to the monsoon (August). This is in perfect accordance with the observation of Borkar and Komarpant, (2004) in Bondla Wildlife Sanctuary, Goa.

The Southern Birdwing, Common Mime, Common Pierrot, Chestnut Streaked Sailer, Danaid Egg fly and Bamboo Tree Brown are protected under the schedule I; Malabar Banded Peacock, Common Gull, and Blue Oak leaf are protected under schedule II and Common Crow are protected under schedule IV of the Indian Wildlife Protection Act (1972). We recorded butterflies from Lycaenidae such as the Plains Cupid, Small Cupid, Common hedge Blue, Common Ape fly, Common Cerulean were found among the grasses during our study period. It is recorded earlier that the members of the Lycaenidae largely feed on grasses (Nimbalkar *et al.*, 2011). Among the Hesperiidae the Bush Hopper and the Chestnut Bob were more abundant falling under the Very common (VC) category. Common Mormons were at their peak period during the post-monsoon and later started declining. The Common Evening Brown and the Dark Evening Brown though considered being nocturnal, were reported twice and once respectively, during our visit in the day time from 8:30 am to 12:00 noon.

The medus browns were more confined to the temple and the forest site during the postmonsoon. The fruits of the Banyan tree are found to be their main source of food but as the number of fruits declined the abundance of this particular species also got reduced. In the case of Tigers, the Plain Tiger was dominating followed by Glassy Tiger, Striped Tiger, and Blue Tiger. A similar pattern was observed by Borkar and Komarpant (2004).

Among the Pansy, the Chocolate Pansy was more abundant followed by Peacock Pansy, Grey Pansy, and Lemon Pansy. Lemon Pansy was reported only once in November. Both the species most of the time are found together in a habitat.

Relative abundance of butterflies greatly varied with respect to habitat and seasons. Among the four sites, forest showed the maximum relative abundance as it is dominated by different plant species and grasses which provide diverse habitat, food and breeding sites for butterflies. Nectar being the major part of their nutrition, the forest area of Rivona consisting several host plants such as Lantana camara, Ixora coccinea, Clerodendrum paniculatum, Calotropis procera, Chromolaena odorata, Stachytarpheta jamai*censis* supported the rich butterfly diversity Similar studies were reported from various parts of the country (Kunte, 2000; Dey et al., 2017; Eswaran et al., 2005; Gaude and Janarthanam, 2015). Pahari et al., (2018) revealed on the study of butterfly diversity in Haldia industrial zone that shows few numbers of butterfly species, less diversity and evenness indices when compared with the adjacent rural belt and also recommend that industrialized areas are harmful places to the butterflies. Leon-Cortes et al., (2015) reported that the most diverse species of butterfly in the study area were belonging to Nymphalidae family with (31) species followed by Hesperidae (12), Pieridae (19) and Lycaenidae (16) respectively. Harsh et al., (2015) investigated that the individuals related to Nymphalidae and Hesperiidae were most prevalent with the 53 species being investigated accounting for 28.71% and 23.76% of total number of individuals collected. Their dominance and evenness were statistically analysed and found that diversity and species richness has significantly declined in the agro ecosystem habitats, probably due to the destruction of host plant in crop area habitat, use of synthetic pesticides, human disturbance and heavy vehicle pollution.

The surplus number of butterfly species specifies a healthier ecosystem. The study reflects that the abundance and diversity of butterflies are more in the forest and near the river and is less near the temple and paddy fields. This may be due to the influence of human activities which created an impact on the diversity and abundance of butterfly species. Most species of butterflies either remain unspotted or declined near the paddy field. One of the reasons could be the regular harvesting of the paddy field. Butterflies will be in trouble due to the destruction of host and larval plantation resulting in difficulty in feeding and laying eggs. Chemical sprays that are used to keep pests away also kill butterflies. Increased human activities were associated with decreased butterfly diversity especially rich, rare, and special species from being most affected (Clark et al., 2007). Butterfly diversity can be protected by planting host-specific local plants to make sure that at least the common species will not go on to the verge of devastation. However, this situation does not arise in Rivona.

CONCLUSION

Butterflies are the assemblages of insects that act as biodiversity indicators as well as nature's gardeners. The reasons for rich butterfly diversity in the Rivona village, it is blessed with dense forest cover and vegetation with refreshing springs, but some anthropogenic activities like tourism, regular harvesting of paddy fields and usage of chemical pesticides reflecting their impact on butterfly diversity in temple and paddy field areas. Proper planning and protection of forest areas are challenging tasks to preserve rich biodiversity for future generations.

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