

**BUTTERFLY DIVERSITY IN THE THREE SELECTED AREAS IN DHAKA CITY, BANGLADESH**Md. Aminul Islam<sup>1\*</sup>, Md. Abul Kashem<sup>2</sup>, Md. Abdul Alim<sup>2</sup>, Fatema-Tuz-Zohora<sup>2</sup>*Department of Zoology, University of Dhaka, Dhaka, Bangladesh*

**Abstract:** The diversity of butterfly species was studied from January to June 2015 in the three selected areas, viz. Ramna Park, Jagannath University Campus, and Baldha Garden in Dhaka city, Bangladesh. A total 75 species of butterfly belonging to 42 genera under 8 families were recorded from the study areas during the study period. Of them, 52 species (6253 individuals) of 8 families were found in the Ramna Park, 37 species (1430 individuals) of 7 families in the Jagannath University Campus and 20 species (320 individuals) of 6 families in the Baldha Garden. In these three study areas, 17 species, 14 genera and 6 families were in common. At the Ramna Park, the highest species richness included the family Lycaenidae (21.15%, 11 spp.) followed by Papilionidae (17.31%, 9 spp.), Pieridae (17.31%, 9 spp.), Nymphalidae (17.31%, 9 spp.), Hesperidae (13.46%, 7 spp.), Danaidae (7.69%, 4 spp.), Satyridae (3.85%, 2 spp.), and the lowest was in the family Acrididae (1.92%, 1 spp.). At the Jagannath University Campus the highest number of species were recorded in the family Lycaenidae (21.62%, 8 spp.) and Hesperidae (21.62%, 8 spp.) followed by Pieridae (18.92%, 7 spp.), Papilionidae (13.51%, 5 spp.), Nymphalidae (10.81%, 4 spp.), Danaidae (10.81%, 4 spp.), and the lowest was in Satyridae (2.70%, 1 spp.). The topmost butterfly species were recorded in the family Pieridae (25%, 5 spp.) followed by Lycaenidae (20%, 4 spp.), Nymphalidae (20%, 4 spp.), Papilionidae (15%, 3 spp.), and the lowest from the family Hesperidae (10%, 2 spp.) and Danaidae (10%, 2 spp.) at the Baldha Garden. The maximum butterfly species were found in February to June (51 spp.), February (34 spp.), and April (16 spp.), and the lowest were in January (46 spp.), June (21 spp.) and January (8 spp.), respectively for the Ramna Park, Jagannath University Campus and the Baldha Garden. The peak of the population observed in May (n = 1285), March (n = 325), and May (n = 71), and the lowest was in January (n = 662), June (n = 145) and January (n = 21), respectively for the Ramna Park, Jagannath University Campus, and Baldha Garden. The Shannon's Diversity Index (H) and Simpson's Index ( $\lambda$ ) indicated high butterfly diversity at the Ramna Park (H = 3.68,  $\lambda$  = 0.03), Jagannath University Campus (H = 3.20,  $\lambda$  = 0.06) and Baldha Garden (H = 2.50,  $\lambda$  = 0.13), respectively. The high Species Evenness in the Ramna Park (E = 0.93), Jagannath University Campus (E = 0.89) and the Baldha Garden (E = 0.84) indicated that the species were evenly distributed. The calculated Sorenson's Coefficient (CC) was 0.47, which indicates that these three communities have quite a bit of overlap or similarity.

**Key words:** Butterfly Diversity, Diversity Index, Species Evenness, Community Similarity, Sorenson's Coefficient.

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## INTRODUCTION

Butterflies are scaled wing insects, which belong to the order Lepidoptera, class Insecta and phylum Arthropoda (Nimblkar *et al.* 2011). They are large and diverse group of animals that are a conspicuous part of virtually all the world's terrestrial ecosystems (Singh 2011). There are more than 17,500 butterflies species under 17 families in the world and 90% of them have been documented (Robbins and Olper 1997). Among them, 1501 species have been recorded from India, 651 species from Nepal, 242 species from Srilanka, 237 species from Japan, 1182 species from Malaysia (Gaonkar 1996). A total of 305 butterflies species under 10 families have been reported from Bangladesh (Bangladesh, I. U. C. N. 2015).

Butterflies have been regarded as the sign of beauty and elegance in nature (Rafi *et al.* 2000). They are important aspects of ecosystem for their interaction with plants as pollinators and herbivores. They occupy a vital position or disproportionate effect on other organisms in different ecosystems and their occurrence and diversity has been invoked as an indicator of biological diversity and good health (Aluri and Rao 2002, Schmucki *et al.* 2015). Butterflies are keystone species of environmental changes as they are sensitive to habitat degradation and climate change (Kunte 2000) due to their rapid life cycle than higher animals and hence can be quicker to react to small changes in their environment (Lafontaine 1997).

Butterfly distribution, diversity, and abundance depend upon the key factors such as the greatest diversity of plants, habitats, topography, and climates (Sarder *et al.* 2016). Butterfly species are generally abundant in tropical area means tropical forest, Shal forest, and tropical rainforest. In Bangladesh very insufficient and limited works have been done on butterfly species diversity, species composition and its distribution pattern (Bashar 2014). Hence, in various ecological pockets of primary and disturbed (human dominated) habitat of butterfly fauna, it requires proper exploration (Sarder *et al.* 2016). Many species of butterflies depend on relic vegetation for survival, especially in urban areas (Blair 1999). Dhaka is the capital of Bangladesh and its climate is very favorable for butterfly species diversity having a tropical Savanna climate. However, no detailed work has done on the diversity of butterfly in Dhaka city. The aim of the present study was to evaluate the diversity, species richness and evenness and community similarity of butterfly fauna of the three selected places of the Dhaka city.

## MATERIAL AND METHODS

*Study area:* The study was conducted in the following 3 selected areas in Dhaka city:

*Ramna Park:* It is located at the center of the Dhaka city. The geological co-ordinates are Latitude: 23°44'14.70" N Longitude: 90°24'03.4" E. The total area is 68.50 acres. There are 71 species of flowering trees, shrubs, perennials, and annuals, 41 species of forestry, 36 species of fruit-bearing plants, 33 species of medicinal plants, and 11 other species.

*Jagannath University Campus:* It is located at the southern part of the Dhaka city. The geological co-ordinates are Latitude: 23°42'32.4" N and Longitude: 90°24'38.16" E. Total area is 7.5 acres. It can be compared with the overall vegetation trend of the Dhaka city. Most of its areas are covered with the concrete buildings while the botanical garden, life, and earth science faculty are the oasis of this area. The variety of species stretches from shrubs to medicinal plant and flower-bearing trees.

*Baldha Garden:* It is located at the south eastern part of the Dhaka city. The geological co-ordinates are Latitude: 23°43'06" N and Longitude: 90°25'04" E. It is 3.15 acres compact area with variety of vegetation. There is a wide variation of floral species occurred in the Baldha garden especially in the psyche section. There are about 600 species of plants from around the world cultured here.

*Materials:* Sweep net, camera, collecting jar and polythene bag, forceps and needle, envelopes, permanent ink pen, label paper and magnifying glass were used as physical materials. The biological materials were butterflies and the related plants.

*Sampling and Identification:* Butterflies were observed during sunny days at a constant speed from 7 am to 2 pm (BST) four days in a month through walking transect (Caldas and Robbins 2003). Butterfly Identification was carried out by using the keys developed and used by Marshall de Niceville (1883), Bingham (1905), Evans (1932), Wynter-Blyth (1957), Talbot (1978), Bashar (2014), and Encyclopedia of fauna (Ahmed *et al.* 2009).

On the basis of abundance the observed butterflies were categorized in five categories in the three study areas. Species which observed a total of abundance exceeding 100 individuals were described as very common (VC: > 100 sightings), common (C: 50–100 sightings), not rare (NR: 15–49 sightings), rare (R: 3–14 sightings), very rare (VR: 1–2 sightings) (Nidup *et al.* 2014).

*Diversity Analysis:* The study used Shannon's Diversity Index (H) (Shannon and Weiner 1949) and Simpson's Index ( $\lambda$ ) (Simpson 1949) as models as a measure of diversity. The equations for the two indices:

Shannon's Diversity Index ( $H$ ) =  $-\sum_{i=1}^S p_i \ln p_i$ , Simpson's Index ( $\lambda$ ) =  $\sum_{i=1}^S p_i^2$

Where,  $p$  is the proportion ( $n/N$ ) of individuals of one particular species found ( $n$ ) divided by the total number of individuals found ( $N$ ),  $\ln$  is the natural log,  $\Sigma$  is the sum of the calculations and  $S$  is the number of species. Optimum values of  $H$  are generally between 1.5 and 3.5 in most ecological researches, and the index is rarely greater than 4. Shannon's Diversity Index is mathematical measurement to define community composition (number of species) and commonness of species in a community. It increases as both the richness and the evenness of the community increase (Shannon and Weiner 1949). Opposite to this, the Simpson's Index ( $\lambda$ ) is the mathematical representation of the similarity index. The range of  $\lambda$  is from 0 to 1 (Simpson 1949). Higher the index means lower the diversity. It is the strength of dominance, because it weights towards the abundance of the most common species and varies inversely with species diversity (Whittaker 1972).

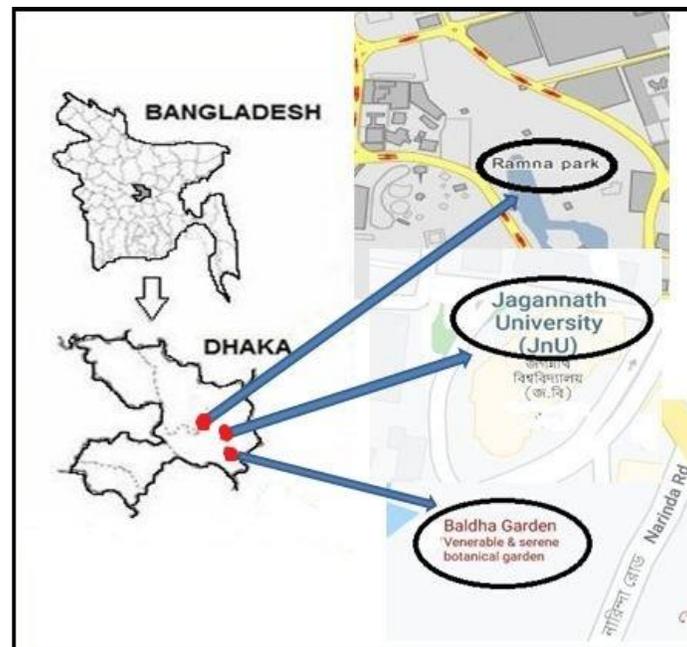


Fig. 1. Map of the Dhaka city in Bangladesh indicating the three study areas.

*Simpson's Index of Diversity (1- $\lambda$ )*: It is a measure of diversity. The probability of two randomly selected individuals in a community belongs to different categories e.g. species. The value of  $1-\lambda$  ranges between 0 and 1, where, high

scores (close to 1) show high diversity and low scores (close to 0) show low diversity (Simpson 1949).

*Simpson's Reciprocal Index (1/λ)*: The relative biodiversity of a community can be measured by it. It can be used to compare communities to identify intrinsic qualities. A high index value indicates a stable site with many different richness and low competition. A low index value shows a site with a few potential niches where only a few species dominate. The index value may alter in response to the ecological interference (MacDonald *et al.* 2017).

*Species evenness (E)*: It refers to how close in number each species an environment is. The equation is:  $E = \frac{H}{\ln(S)}$ . The range of E is from 0 to 1. The value of E trends to 0 indicates that the species is more dominant in a community, E nears to 1 refers to evenly distributed (Shannon and Weiner 1949).

*Community Similarity*: It is measured by Sorenson's Coefficient (CC). The equation is: Sorenson's Coefficient (CC) =  $\frac{3C}{S_1+S_2+S_3}$ , Where C is the number of species the three communities have in common, S<sub>1</sub> is the total number of species found in community 1, S<sub>2</sub> is the total number of species found in community and S<sub>3</sub> is the total number of species found in community 3 (Sorensen 1948). Sorenson's coefficient gives a value between 0 and 1, the closer the value is to 1, the more the communities have in common. Entire community overlap is equal to 1; entire community dissimilarity is equal to 0 (Sorensen 1948).

## RESULTS AND DISCUSSION

A total of 8003 butterflies of 75 species belonging to 42 genera under 8 families were recorded from the Ramna Park, Jagannath University Campus and Baldha Garden in Dhaka city (Table 1, 2 and 3). Of them, 52 species (6253 individuals) under 8 families were found in the Ramna Park (Table 1), 37 species (1430 individuals) belongings to 7 families in the Jagannath University Campus (Table 2) and 20 species (320 individuals) of under 6 families in the Baldha Garden (Table 3). In these three study areas, 17 species, 14 genera and 6 families were in common.

About 430 species of butterfly are known to Bangladesh (Bashar 2014). Out of the above estimated species only 75 species of 8 families were recorded from the three selected areas in the Dhaka city in this study. Present investigation revealed that there were no new species, these areas were excellent for the occurrence of common species availability, Sarder *et al.* (2016) stated that in disturbed habitats and anthropogenic affected sites species richness was

**Table 1: Illustration how the various indices change as the relative number of each butterfly species change in the Ramna Park**

Family name	Scientific name	Common name	Monthly Abundance						Total (n)	Status	Pi	Pi <sup>2</sup>	PinPi
			Jan	Feb	Mar	Apr	May	Jun					
Danaidae	<i>Danaus chrysippus</i>	Plain Tiger	12	14	18	27	24	31	126	VC	0.020150328	0.000406036	-0.078677655
	<i>Danaus genutia</i>	Striped Tiger	8	15	22	19	25	24	113	VC	0.018071326	0.000326573	-0.072527979
	<i>Tirumala limniace exotocus</i>	Blue Tiger	9	12	18	19	16	17	91	C	0.014553015	0.00021179	-0.061558628
	<i>Euploea core</i>	Common Crow	16	14	23	34	28	30	145	VC	0.023188869	0.000537724	-0.087284826
Papilionidae	<i>Pachliopta aristolochiae</i>	Common Rose	7	10	15	12	17	13	74	C	0.01183432	0.000140051	-0.052505935
	<i>Pachliopta hector</i>	Crimson Rose	1	0	3	2	5	1	12	R	0.001919079	3.68289E-06	-0.021005584
	<i>Papilio polytes romulus</i>	Common Mormon	6	11	18	29	24	32	120	VC	0.019190788	0.000368286	-0.075867421
	<i>Papilio polymnestor</i>	Blue Mormon	2	9	14	11	8	13	57	C	0.009115625	8.30948E-05	-0.042823065
	<i>Papilio demoleus</i>	Lime Butterfly	6	10	18	12	16	21	83	C	0.013273629	0.000176189	-0.057368305
	<i>Papilio clytia</i>	Common Mime	1	7	12	9	14	17	60	C	0.009595394	9.20716E-05	-0.044584731
	<i>Graphium agamemnon</i>	Tailed Jay	0	2	6	5	3	8	24	NR	0.003838158	1.47315E-05	-0.021350761
	<i>Graphium doson axion</i>	Common Jay	11	10	27	22	25	32	127	VC	0.020310251	0.000412506	-0.079141524
	<i>Graphium sarpedon</i>	Common	2	4	1	6	8	5	26	NR	0.004158004	1.7289E-05	-0.022797173
		<i>Bluebottle</i>											
Pieridae	<i>Catopsilia pyranthe</i>	Mottled Emigrant	8	11	18	14	10	18	79	C	0.012633936	0.000159616	-0.055227592
	<i>Catopsilia pomona</i>	Lemon Emigrant	16	31	38	25	42	36	188	VC	0.030065569	0.000903938	-0.105361017
	<i>Eurema blanda silhetana</i>	Three-Spot Grass Yellow	84	90	121	133	98	112	638	VC	0.102031025	0.01041033	-0.232883605
	<i>Eurema hecabe hecabe</i>	Common Grass Yellow	38	44	32	42	128	61	345	VC	0.055173517	0.003044117	-0.159852697
	<i>Appias libythea</i>	Striped Albatross	18	13	22	31	38	29	151	VC	0.024148409	0.000583146	-0.089917488
	<i>Leptasia nina</i>	Psyche	48	34	44	66	47	52	291	VC	0.046537662	0.002165754	-0.142753969
	<i>Delias eucharis</i>	Common Jezebel	12	19	28	46	34	31	170	VC	0.02718695	0.00073913	-0.09800945
	<i>Cepora nerissa</i>	Common Gull	0	4	12	7	9	8	40	NR	0.006396929	4.09207E-05	-0.032316886
	<i>Artogeia canidia indica</i>	Indian Cabbage White	5	3	16	18	8	6	56	C	0.008955701	8.02046E-05	-0.042230295
	Nymphalidae	<i>Phalanta phalantha</i>	Common Leopard	12	28	19	22	15	17	113	VC	0.018071326	0.000326573
<i>Hypolimnas bolina bolina</i>		Great Eggfly	23	26	28	33	21	16	147	VC	0.023508716	0.00055266	-0.088166713
<i>Anadhe merione tapestrina</i>		Common Castor	11	18	37	32	42	26	166	VC	0.026547257	0.000704757	-0.096335453
<i>Euthalia aconthea</i>		Common Baron	18	14	32	44	47	33	188	VC	0.030065569	0.000903938	-0.105361017
<i>Junonia atlites</i>		Grey Pansy	7	13	28	31	18	16	113	VC	0.018071326	0.000326573	-0.072527979
<i>Junonia almanac</i>		Peacock Pansy	19	10	29	33	42	14	147	VC	0.023508716	0.00055266	-0.088166713
<i>Junonia orithya</i>		Blue Pansy	0	6	8	15	4	7	40	NR	0.006396929	4.09207E-05	-0.032316886
<i>Junonia lemonias</i>		Lemon Pansy	16	27	34	28	46	31	182	VC	0.029106029	0.000847161	-0.102942493
<i>Neptis hylas</i>		Common Sailor	28	31	39	31	37	21	187	VC	0.029905645	0.000894348	-0.104960083
<i>Castalius rosomon</i>		Common Pierrot	7	16	21	31	27	23	125	VC	0.019990405	0.000399616	-0.078212516
Lycaenidae	<i>Jamides bochus</i>	Dark Cerulean	3	18	23	16	27	6	93	C	0.014872861	0.000221202	-0.062588229
	<i>Zizeeria karsandra</i>	Dark Grass Blue	18	23	31	39	12	15	138	VC	0.022069407	0.000487059	-0.084163071
	<i>Pseudozizeeria maha maha</i>	Pale Grass Blue	25	33	43	17	21	9	148	VC	0.023668639	0.000560204	-0.08860602
	<i>Proscotus dubiosa</i>	Tailless Line Blue	1	8	2	0	3	0	14	R	0.002238925	5.01279E-06	-0.013661383
	<i>Neopitheops zalmora</i>	Quaker	6	11	9	4	15	7	52	C	0.008316008	6.9156E-05	-0.039830128
	<i>Euchrysops cnejus</i>	Gram Blue	18	16	31	17	13	11	106	VC	0.016951863	0.000287366	-0.069119146
	<i>Chilades lajus</i>	Lime Blue	11	17	12	14	21	8	83	C	0.013273629	0.000176189	-0.057368305
	<i>Chilades pandava</i>	Plains Cupid	0	2	7	3	2	1	15	NR	0.002398849	5.75447E-06	-0.014471693
	<i>Lampides boeticus</i>	Pea Blue	28	31	34	43	39	33	208	VC	0.033264033	0.001106496	-0.113206771
	<i>Catochrysops strabo</i>	Forget-me-not	17	21	18	27	32	15	130	VC	0.020790021	0.000432225	-0.080525617
Hesperiidae	<i>Sausthus gremius</i>	Indian Palm Bob	9	7	0	6	4	3	29	NR	0.004637774	2.15089E-05	-0.024921174
	<i>Barbo cinnara</i>	Rice Swift	6	11	21	17	14	15	84	C	0.013433552	0.00018046	-0.057898606
	<i>Pelopidas conjuncta</i>	Conjoined Swift	15	21	27	12	3	11	89	C	0.014233168	0.000202583	-0.060521996
	<i>Pamara guttatus mangala</i>	Straight Swift	0	2	7	4	19	33	65	C	0.01039501	0.000108056	-0.047468081
	<i>Oriens gola</i>	Common Dartlet	0	3	1	7	3	2	16	NR	0.002558772	6.54731E-06	-0.015271333
	<i>Oriens goloides</i>	Smaller Dartlet	3	11	15	12	19	17	77	C	0.012314089	0.000151637	-0.054145188
Satyridae	<i>Badamia exclamationis</i>	Brown Awl	2	5	3	2	0	7	19	NR	0.003038542	9.23273E-06	-0.017612534
	<i>Elymnias hypermnestra</i>	Common Palmfly	8	14	21	18	25	23	109	VC	0.017431633	0.000303862	-0.070588852
	<i>Melanitis leda</i>	Common Evening Brown	18	21	27	31	46	37	180	VC	0.028786183	0.000826644	-0.102129339
Acriidae	<i>Acraea violae</i>	TwanyCoster	23	35	29	24	41	22	174	VC	0.027826643	0.000774322	-0.099668395
Total (Σ)	S = 52		662	866	1162	1202	1285	1076	6253		1	0.032403906	-3.682330281

Shannon's Diversity Index (H) = 3.68, Simpson's Diversity Index (A) = 0.03, Simpson's Index of Diversity (1-A) = 0.97, Simpson's Reciprocal Index (1/A) = 30.86 and Species Evenness (E) = 0.93.

The maximum population was recorded in the month of May (20.55%) followed by April (19.22%), March (18.58%), June (17.21%), February (13.85%) and the minimum of January (10.59%) (Fig. 6). increased but the uniqueness was less. These results are in good agreement with Padhey *et al.* (2012).

At the Ramna Park, family-wise species richness and butterfly population are shown in Fig. 3 and 5, respectively. The maximum species richness included the family Lycaenidae (21.15%, 11 spp.) followed by Papilionidae (17.31%, 9

**Table 2. Illustration how the various indices change as the relative number of each butterfly species change in the Jagannath University Campus**

Family Name	Scientific name	Common name	Monthly Abundance						Total	Status	Pi	Pi <sup>2</sup>	PiInPi
			Jan	Feb	Mar	Apr	May	Jun					
Danaidae	<i>Danaus chrysippus</i>	Plain Tiger	11	15	21	25	14	0	86	C	0.06013986	0.003616803	-0.169058104
	<i>Danaus genutia</i>	Striped Tiger	8	12	9	2	0	0	31	NR	0.021678322	0.00046995	-0.083059243
	<i>Tirumala limniace exotocus</i>	Blue Tiger	2	1	7	5	1	0	16	NR	0.011188811	0.000125189	-0.05026955
	<i>Euploea core</i>	Common Crow	1	4	13	5	1	0	24	NR	0.016783217	0.000281676	-0.068599316
Papilionidae	<i>Pachliopta aristolochiae</i>	Common Rose	12	10	2	1	0	0	25	NR	0.017482517	0.000305638	-0.070743949
	<i>Papilio polytes romulus</i>	Common Mormon	6	11	14	17	12	11	71	C	0.04965035	0.002465157	-0.14908758
	<i>Papilio demoleus</i>	Lime Butterfly	6	10	11	8	13	2	50	C	0.034965035	0.001222554	-0.117251983
	<i>Papilio clytia</i>	Common Mime	1	3	0	0	1	2	7	R	0.004895105	2.39621E-05	-0.026039606
	<i>Graphium doson axion</i>	Common Jay	0	0	2	7	4	3	16	NR	0.011188811	0.000125189	-0.05026955
	<i>Catopsilia pyranthe</i>	Mottled Emigrant	1	5	9	2	0	1	18	NR	0.012587413	0.000158443	-0.05507066
Pieridae	<i>Catopsilia pomona</i>	Lemon Emigrant	0	3	8	15	12	6	44	NR	0.030769231	0.000946746	-0.10711508
	<i>Eurema blanda silhetana</i>	Three-Spot Grass Yellow	28	35	44	42	31	33	213	VC	0.148951049	0.022186415	-0.283623287
	<i>Eurema hecabe hecabe</i>	Common Grass Yellow	18	24	23	31	28	27	151	VC	0.105594406	0.011150178	-0.237392051
	<i>Appias libythea</i>	Striped Albatross	11	13	0	0	1	2	27	NR	0.018881119	0.000356497	-0.074950355
	<i>Leptosia nina</i>	Psyche	8	14	18	1	0	0	41	NR	0.028671329	0.000822045	-0.101836478
	<i>Delias eucharis</i>	Common Jezebel	2	0	0	0	1	0	3	R	0.002097902	4.40119E-06	-0.012937379
	<i>Phalanta phalantha</i>	Common Leopard	12	28	19	22	15	17	113	VC	0.079020979	0.006244315	-0.200558556
	<i>Hypolimnas bolina bolina</i>	Great Egfly	5	1	14	11	8	3	42	NR	0.029370629	0.000862634	-0.103612535
	<i>Junonia atlites atlites</i>	Grey Pansy	4	3	12	7	2	2	30	NR	0.020979021	0.000440119	-0.081067811
	<i>Junonia almanac</i>	Peacock Pansy	1	0	4	7	10	1	23	NR	0.016083916	0.000258692	-0.066425536
Lycaenidae	<i>Castalius rosomon</i>	Common Pierrot	9	7	15	13	5	3	52	C	0.036363636	0.001322314	-0.120515855
	<i>Jamides bochus</i>	Dark Cerulean	3	1	7	10	0	0	21	NR	0.014685315	0.000215658	-0.061985352
	<i>Zizeeria karsandra</i>	Dark Grass Blue	0	2	5	9	7	9	32	NR	0.022377622	0.000500758	-0.085028113
	<i>Pseudozeeria maha</i>	Pale Grass Blue	5	13	11	6	8	7	50	C	0.034965035	0.001222554	-0.117251983
	<i>Prosotas dubiosa</i>	Tailless Line Blue	0	3	5	9	12	0	29	NR	0.02027972	0.000411267	-0.079053065
	<i>Euchrysops cnejus</i>	Gram Blue	5	7	11	6	3	2	34	NR	0.023776224	0.000565309	-0.088900946
	<i>Chilades lajus</i>	Lime Blue	3	1	8	10	5	4	31	NR	0.021678322	0.00046995	-0.083059243
	<i>Lampides boeticus</i>	Pea Blue	0	4	3	1	0	0	8	R	0.005594406	3.12974E-05	-0.029012521
	<i>Sausturus gremius</i>	Indian Palm Bob	7	5	3	4	0	0	19	NR	0.013286713	0.000176537	-0.057411765
	<i>Borbo cinnara</i>	Rice Swift	3	2	0	5	4	4	18	NR	0.012587413	0.000158443	-0.05507066
Hesperiidae	<i>Pelopidas conjuncta</i>	Conjoined Swift	3	2	3	0	0	0	8	R	0.005594406	3.12974E-05	-0.029012521
	<i>Pamara guttatus mangala</i>	Straight Swift	2	4	2	1	2	0	11	R	0.007692308	5.91716E-05	-0.037442573
	<i>Tagiade sjapetus</i>	Pied Flat	0	1	2	0	0	0	3	R	0.002097902	4.40119E-06	-0.012937379
	<i>Oriens gola</i>	Common Dartlet	1	3	3	2	0	0	9	R	0.006293706	3.96107E-05	-0.031897795
	<i>Oriens goloides</i>	Smaller Dartlet	3	2	3	0	1	0	9	R	0.006293706	3.96107E-05	-0.031897795
	<i>Badamia exclamationis</i>	Brown Awl	0	4	7	15	13	5	44	NR	0.030769231	0.000946746	-0.10711508
	<i>Mycalesis perseus blasius</i>	Common Bushbrown	3	8	7	2	0	1	21	NR	0.014685315	0.000215658	-0.061985352
	<b>Total (Σ)</b>	<b>S=37</b>		184	261	325	301	214	145	1430		1	0.058477187

Shannon's Diversity Index (H) = 3.20, Simpson's Diversity Index, (λ) = 0.058, Simpson's Index of Diversity (1-λ) = 0.94, Simpson's Reciprocal Index (1/λ) = 17.10 and Species Evenness (E) = 0.89

spp.), Pieridae (17.31%, 9 spp.), Nymphalidae (17.31%, 9 spp.), Hesperidae (13.46%, 7 spp.), Danaidae (7.69%, 4 spp.), Satyridae (3.85%, 2 spp.), and the minimum was in the family Acrididae (1.92%, 1 spp.). The highest butterfly

population was in the family Pieridae (1958 individuals) followed by Nymphalidae (1283 individuals), Lycaenidae (1112 individuals), Papilionidae (583 individuals), Danaidae (475 individuals), Hesperidae (379 individuals), Satyridae (289 individuals), and the lowest was in the family Acrididae (174 individuals) (Fig. 5). Among them, *Eurema blanda silhetana* (n=638) was the most dominant species followed by *Eurema hecabe* (n=345) and *Leptosia nina* (n=291) (Table 1). On the other hand, *Pachliopta hector* (n=12) was in the lowest population followed by *Prosotas dubiosa* (n=14) *Chilades pandava* (n=15), *Oriens gola* (n=16) and

**Table 3. Illustration how the various indices change as the relative number of each butterfly species change in the Baldha Garden**

Family name	Scientific name	Common name	Monthly Abundance						Total	Status	Pi	Pi <sup>2</sup>	Pi/nPi
			Jan	Feb	Mar	Apr	May	Jun					
Danaidae	<i>Danaus chrysippus</i>	Plain Tiger	0	2	4	4	12	4	26	NR	0.08125	0.006601563	-0.203955737
	<i>Euploea core</i>	Common Crow	1	3	0	0	1	0	5	R	0.015625	0.000244141	-0.064982548
Papilionidae	<i>Pachliopta aristolochiae</i>	Common Rose	0	0	2	3	0	2	7	R	0.021875	0.000478516	-0.083615237
	<i>Papilio polytes romulus</i>	Common Mormon	0	2	1	1	0	2	6	R	0.01875	0.000351563	-0.074560529
Pieridae	<i>Papilio demoleus</i>	Lime Butterfly	0	0	0	0	2	0	2	VR	0.00625	3.90625E-05	-0.031719836
	<i>Catopsilia pomona</i>	Lemon Emigrant	0	3	2	7	4	3	19	NR	0.059375	0.003525391	-0.167667995
	<i>Eurema blanda silhetana</i>	Three-Spot Grass Yellow	0	5	3	10	12	9	39	NR	0.121875	0.014853516	-0.256517546
	<i>Eurema hecabe hecabe</i>	Common Grass Yellow	1	4	3	7	9	4	28	NR	0.0875	0.00765625	-0.213160192
	<i>Lepto sianina</i>	Psyche	5	4	4	6	0	1	20	NR	0.0625	0.00390625	-0.173286795
	<i>Delias eucharis</i>	Common Jezebel	2	0	0	0	1	0	3	R	0.009375	8.78906E-05	-0.043778519
	<i>Hypolimnas bolinabolina</i>	Great Egfly	1	2	0	3	1	0	7	R	0.021875	0.000478516	-0.083615237
	<i>Junonia atlites atlites</i>	Grey Pansy	1	2	1	3	2	4	13	R	0.040625	0.001650391	-0.130136973
Nymphalidae	<i>Junonia almanac</i>	Peacock Pansy	0	0	0	3	2	3	8	R	0.025	0.000625	-0.092221986
	<i>Neptishylas</i>	Common Sailor	2	0	1	3	4	0	10	R	0.03125	0.000976563	-0.108304247
Lycaenidae	<i>Zizeeria karsandra</i>	Dark Grass Blue	0	2	1	3	3	0	9	R	0.028125	0.000791016	-0.100437087
	<i>Pseudozizeer iamaha</i>	Pale Grass Blue	8	11	15	18	15	24	91	C	0.284375	0.080869141	-0.357590611
	<i>Zizula hylax</i>	Tiny Grass Blue	0	0	3	1	1	0	5	R	0.015625	0.000244141	-0.064982548
	<i>Euchrysops cnejus</i>	Gram Blue	0	3	5	1	0	2	11	R	0.034375	0.001181641	-0.115858384
Hesperidae	<i>Parnara guttatus</i>	Straight Swift	0	3	2	1	2	0	8	R	0.025	0.000625	-0.092221986
	<i>Tagiades japetus</i>	Pied Flat	0	1	2	0	0	0	3	R	0.009375	8.78906E-05	-0.043778519
Total(Σ)	S=20		21	47	49	74	71	58	320		1	0.125273438	2.502392514

Shannon's Diversity Index, H = 2.50, Simpson's Index, λ = 0.13, Simpson's Index of Diversity, 1-λ = 0.87, Simpson's Reciprocal Index, 1/λ = 7.98 and Species Evenness, E = 0.84.

VC-Very Common (> 100 sightings), C - Common (50–99 sightings), NR - Not Rare (15–49 sightings), R - Rare (3–14 sightings), VR - Very Rare (1–2 sightings) (Nidup et al. 2014).

*Badamia exclamationis* (n=19) (Table 1). Among observed species, 28 were very common, 14 were common, 8 were not rare, and 2 were rare (Table 1). An analogous study was carried out by Koirala et al. (2020) at Gidakom Forest

management Unit, Thimpu, Bhutan that revealed a total of 90 species under 52 genera and 5 families. Nymphalidae was dominant with 38 species followed by Lycaenidae with 19, Pieridae with 15, Papilionidae with 11, and Hesperidae with 7 species.

Family-wise species richness and butterfly population are shown in figure 3 and 5, respectively at the Jagannath University Campus. The maximum species were recorded in the family Lycaenidae (21.62%, 8 spp.) and Hesperidae (21.62%, 8 spp.) followed by Pieridae (18.92%, 7 spp.), Papilionidae (13.51%, 5 spp.), Nymphalidae (10.81%, 4 spp.), Danaidae (10.81%, 4 spp.), and the minimum was in Satyridae (2.70%, 1 spp.). The highest butterfly population was in the family Pieridae (497 individuals) followed by Lycaenidae (257 individuals), Nymphalidae (208 individuals), Papilionidae ( 169 individuals),

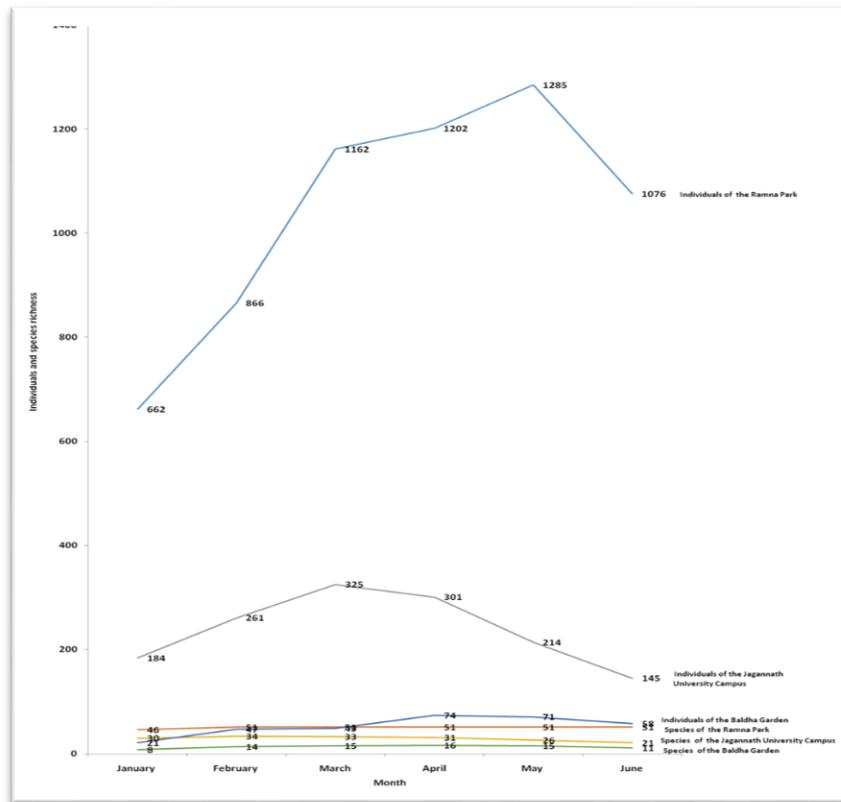


Fig. 2. Species richness and individuals curves for pooled data over six months.

Danaidae (157 individuals), Hesperidae (121 individuals), and the lowest was in the family Satyridae (21 individuals). The maximum population was recorded in

the month of March (22.73%) followed by April (21.05%), February (18.25%), May (14.97%), January (12.86%) and the minimum of June (10.14%) (Fig. 6). Among them, *Eurema blanda silhetana* (n=213) was the most dominant species followed by *Eurema hecabe* (n=151) and *Phalanta phalantha* (n=113). On the other hand, *Tagiades japetus* (n=3) and *Delias eucharis* (n=3) were in the lowest

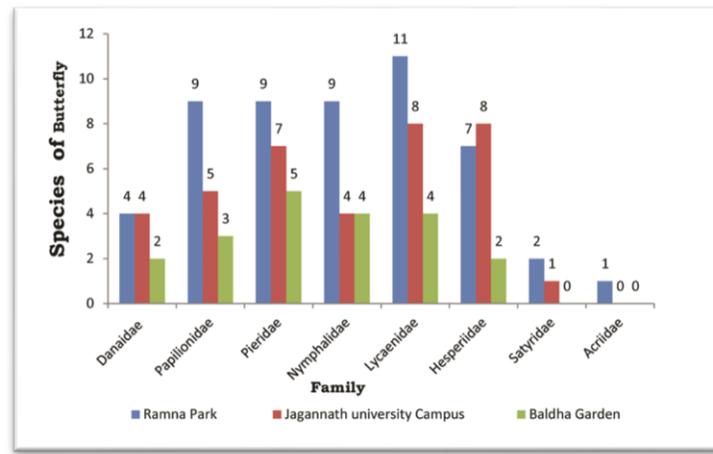


Fig. 3. Family-wise species at the three selected areas of the Dhaka city.

population followed by *Papilio claytia* (n=7), *Lampides boeticus* (n=8), *Pelopidas conjuncta* (n=8), *Oriens gola* (n=9), *Oriens goloides* (n=9), *Parnara guttatus mangala* (n=11), *Graphium doson* (n=16), *Trirumala limniace* (n=16), *Catopsilia pyranthe* (n=18), *Borbo cinnara* (n=18) and *Saustrus gremius* (n= 19) (Table 2). Among observed species, 3 were very common, 5 were common, 21 were not rare and 8 were rare (Table 2). Similar work of Sarder *et al.* (2016) recorded 42 species under 8 families at Keranigonj, out of the recorded families, Pieridae (36.59%) was in the highest population, then Nymphalidae (24.08%), Lycaenidae (16.49%), Danaidae (13.89%), Hesperidae (6.45%), Acrididae (1.29%), Satyridae (0.73%) and Papilionidae (0.45%).

At the Baldha garden, family-wise species richness and butterfly population are shown in Fig. 3 and 5, respectively. The topmost species were recorded in the family Pieridae (25%, 5 spp.) followed by Lycaenidae (20%, 4 spp.), Nymphalidae (20%, 4 spp.), Papilionidae (15%, 3 spp.), and the lowest from the family Hesperidae (10%, 2 spp.) and Danaidae (10%, 2 spp.) at the Baldha Garden. The highest butterfly population was in the family Lycaenidae (116 individuals) followed by Pieridae (109 individuals), Nymphalidae (38

individuals), Danaidae (31 individuals), Papilionidae (15 individuals), and the lowest was in the family Hesperidae (11 individuals). The maximum population was recorded in the month of April (23.12%) followed by May (22.19%), June (18.12%), March (15.31%), February (14.69%) and the minimum of January (6.56%) (Fig.6). Among them, *Pseudozizeeria maha* (n=91) was the most dominant species followed by *Eurema blanda silhetana* (n=39), *Eurema hecabe* (n=28) and *Danaus crysippus* (n=26). On the other hand, *Papilio demoleus* (n=2) was in the lowest population followed by *Delias eucharis* (n=3) *Tagiades japetus* (n=3), *Euploea core* (n=5), *Zizula hylax* (n=5) and *Papilio polytes* (n=6) (Table 3). Among observed species, 1 was common, 5 were not rare, 13 were rare, and 2 were very rare (Table 3). Nidup *et al.* (2014) recorded 91 species belonging to 5 major families of which 1 species was new in Royal Monas National Park, Bhutan. Nymphalidae was the most common (33%, n = 30), and the lowest was hesperiidae (12%, n=11).

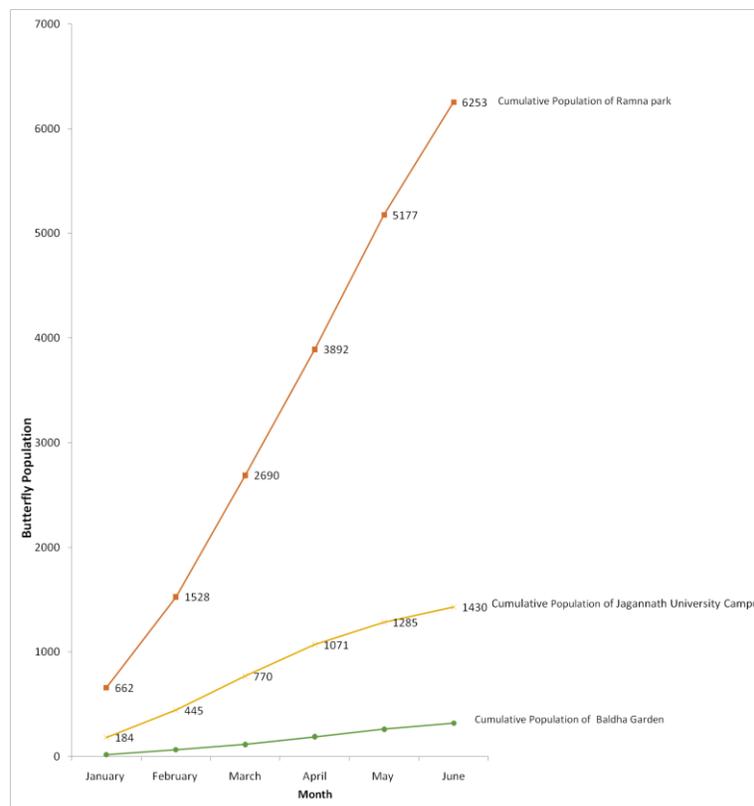


Fig. 4. Month-wise population cumulative curve of faunal assemblage of butterfly at the three selected areas of the Dhaka city.

The value of various indices of species diversity in the Ramna Park, Jagannath University Campus and Baldha Garden are shown in Table 1, 2 and 3, respectively. The values of Shannon's Diversity Index (H), the Simpson's Index ( $\lambda$ ), Simpson's Index of Diversity ( $1 - \lambda$ ), Simpson's Reciprocal Index ( $1 / \lambda$ ) and the Species Evenness (E), are 3.68, 0.032, 0.97, 30.86 and 0.93, respectively for the Ramna Park (Table 1). The values of Shannon's Diversity Index (H), the Simpson's Diversity Index ( $\lambda$ ), Simpson's Index of Diversity ( $1 - \lambda$ ), Simpson's Reciprocal Index ( $1 / \lambda$ ) and the Species Evenness (E) are 3.20, 0.058, .094, 17.1 and 0.89, respectively for the Jagannath University (Table 2). The values of Shannon's Diversity Index (H), the Simpson's Index ( $\lambda$ ), Simpson Index of Diversity ( $1 - \lambda$ ) and Simpson Reciprocal Index ( $1 / \lambda$ ) and the Species Evenness (E) are 2.50, 0.13, 0.87, 7.98 and 0.84, respectively for the Baldha Garden (Table 3).

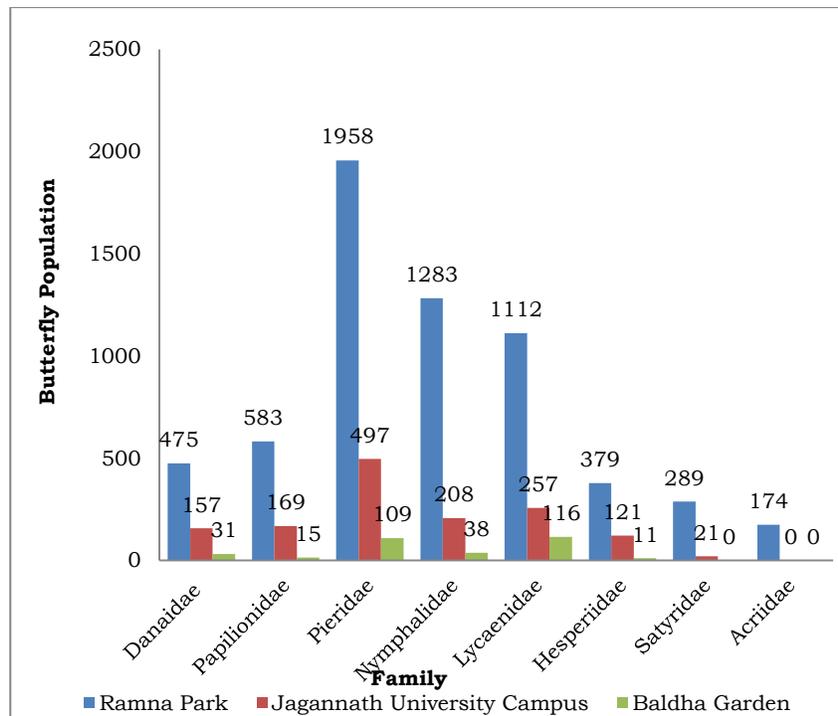


Fig. 5. Family-wise population of butterfly at the three selected areas of the Dhaka city.

The diversity indices H and  $\lambda$  appear useful as it incorporates species richness (Ganeshaih *et al.* 1997). In this study Shanon's Diversity Index appears to have high value ( $H=3.68$  for the Ramna Park,  $H=3.20$  for the Jagannath University Campus and  $H=2.50$  for the Baldha garden) and Simpson's Index ( $\lambda$ ) gave the

low value ( $\lambda = 0.03$  for the Ramna park,  $\lambda = 0.06$  for the Jagannath University and  $\lambda = 0.13$  for the Baldha garden) indicating plenteous diversity richness for butterfly species in these three selected areas. These also indicate

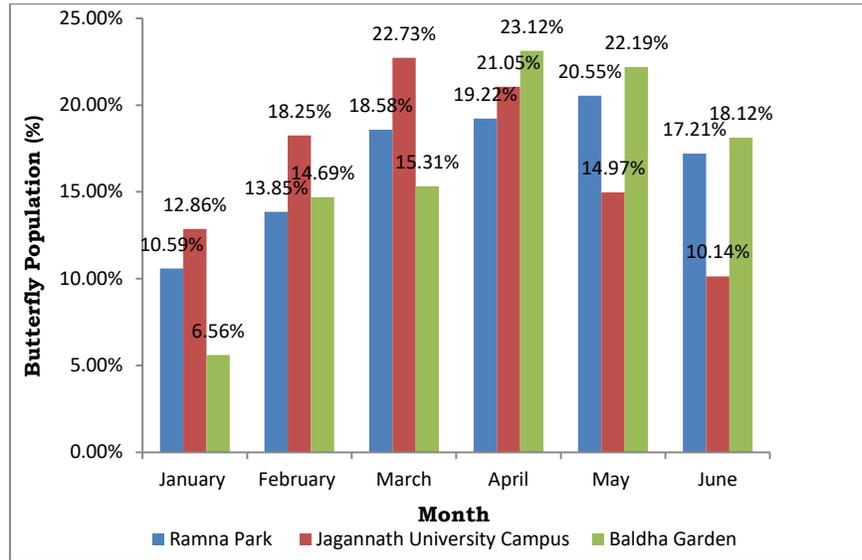


Fig. 6. Month-wise population of butterfly (%) at the three selected areas of the Dhaka city.

Table 4. Community Similarity among the Ramna Park, Jagannath University Campus and Baldha Garden

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Community Similarity is measured by Sorenson's Coefficient (CC).  
 The equation is: 
$$\text{Sorenson's Coefficient (CC)} = \frac{3C}{S_1+S_2+S_3}$$
  
 Where,  
 The number of species in the three communities (Ramna Park, Jagannath University Campus and Baldha Garden) have in common (C) = 17, The total number of species found in the Ramna Park (S<sub>1</sub>) = 52, The total number of species found in the Jagannath University Campus (S<sub>2</sub>) = 37, and the total number of species found in the Baldha Garden (S<sub>3</sub>) = 20.  

$$\text{Sorenson's Coefficient (CC)} = \frac{3C}{S_1+S_2+S_3} = \frac{3 \times 17}{52+37+20} = \frac{51}{109} = 0.47.$$

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that the highest diversity of these three areas is in the Ramna Park, and the lowest is in the Baldha Garden, since the value of  $\lambda$  decrease with the increasing diversity (Ludwing and Reynolds 1988). The Shannon-Wiener Index of diversity has demonstrated some sort of contradictory outcome, interference habitat or forest gaps have higher butterfly diversity than that in closed canopy or dense forests (Wood and Gillman 1998). Nidup *et al.* (2014) described Shannon's Diversity Index 3.16 indicated high butterfly diversity in Royal Monas National Park, Bhutan. Simpson's Index of Diversity of these three areas indicated high

butterfly diversity of which the topmost diversity was in the Ramna Park, and the lowest was in the Baldha Garden. The Simpson's Reciprocal Index is also shown high butterfly diversity of these areas. According to the index values the maximum and minimum diversity was found as same as Simpson's Index of Diversity

Evenness index provides and insight into the relative abundance of the species in the community. The value of E tend to be zero indicates that the species become more dominant in a community (Sanjayan *et al.* 1995). In this study, the value of E (0.93) for the Ramna Park is so high while the Jagannath University (E=0.89) and Baldha Garden (E=0.84) also have high value of E that indicates the species are evenly distributed.

Community Similarity among the Ramna Park, Jagannath University Campus and Baldha Garden is shown in Table 4. The value of Sorenson's Coefficient (CC) of these communities is 0.47. The range of it is from 0 to 1, the closer the value is to 1, the more the communities have in common (Sorensen 1948). According to Sorenson's Coefficient these three communities have quite a bit of overlap or similarity.

### CONCLUSION

The present research has revealed butterfly biodiversity and prepared checklists in the study areas. This study revealed 75 butterfly species belongings to 42 genera under 8 major families. On the basis of the data, conservation of wide range of indigenous butterfly fauna in these small human dominated landscapes might be a good model for maintaining most favourable habitat within fragments.

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