Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(3): 1348-1356

Received: 02-03-2018
Accepted: 03-04-2018

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Diversity and status of butterflies at different sacred forests of Kathmandu valley, Nepal

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Abstract
The present investigation was conducted to study the diversity and status of butterflies at different sacred forests of Kathmandu valley, Nepal. Study was conducted at four sacred forests; Suryabinayak Sacred Forest (SSF), Dakshinkali Sacred Forest (DSF), Swyambhunath Sacred Forest (SwSF) and Pashupatinath Sacred Forest (PSF) of Kathmandu valley, throughout the year 2017. The status of butterflies was categorized into four categories; very rare, rare, fairly common and common on the basis of number of individual encountered. A total of 77 butterfly species under 56 genera and six families were recorded. Family Nymphalidae represented the highest butterfly abundance and richness and found dominated in all sacred forest. *Pieris canidia* was the most abundant species recorded throughout the study period. SSF contributed highest abundance and richness of butterfly with four rare, 19 rare, 21 fairly common and 18 common butterfly species. Unmanaged pollution, high human intervention, number of open access tracks etc. were the major threats we reported basically in the SwSF and PSF. This is the first comprehensive study on butterflies at sacred forests of Nepal. Hence, we strongly recommend to address such issues through scientific research and ecological study for conservation.

Keywords: Kathmandu valley, sacred forests, butterfly population, status, conservation

Introduction
Sacred forests that often found around the temples or stupas [11] are considered as the tract of virgin forest harboring rich biodiversity [12]. These forests are referred as the sites that carry cultural and religious significance [25]. They are protected by the people who living around for cultural significance, religious belief, burial grounds, and watershed value [4, 16, 20, 24]. The sacred forests had been recognized since the start of human primitive ages [30]. Later, the forests are allied with spiritual significance of people [3] and initially, the forests were conserved for spiritual reasons across the world [24, 29]. Nevertheless, the role of sacred forest in bio-diversity conservation has long been recognized [7]. The sacred forest often have associated myths and taboos on the use of specific plants and hunting of certain animals within the area [24]. These sites are the *in-situ* strategies for the biodiversity conservation [21, 30] and known to provide ecosystem services and maintenance of water quality [37].
Nepal, though a small country, people of different castes are living from the primitive time following different cultures, religions and worshipping different Gods and Goddess. As a result, Nepal is rich and well known in its ethnic diversity, culture and religion in the world [29]. Nepal occupies large number of sacred forests with varies in sizes ranged from hundreds of hectares of forest to small areas [11, 29]. Despite their high conservation value such forests are facing severs conservation threats, thus result losing its biodiversity rapidly [29, 30] which need to be address soon.
Documentation and status of faunas from the sacred forest of Nepal are underappreciated. The detail study on butterfly species of sacred forests of Nepal had never been conducted yet. Therefore, the major aim of the study is to explore the diversity and conservation status of butterfly species from different sacred forests of Kathmandu valley and also aimed to acknowledge the important of sacred forests on butterfly conservation.

Materials and Methods
Study Area
The present study was conducted in four sacred forests of Kathmandu valley; Swyambhunath Sacred Forest (SwSF) (Lat. 27˚42' 52'' N, Long. 85˚17' 25'' E and Elevation: 1378 m),

Pashupatinath Sacred Forest (PSF) (Lat. 27˚42' 27'' N, Long. 85˚21' 04'' E and Elevation: 1311 m) and Dakshinkali Sacred Forest (DSF) (Lat. 27˚37' 11'' N, Long. 85˚15' 04'' E and Elevation: 1509 m) of Kathmandu district and Suryabinayak Sacred Forest (SSF) (Lat. 27˚38' 54'' N, Long. 85˚26' 85'' E and Elevation: 1560 m) of Bhaktapur district (Fig. 1). Pashupatinath temple is regarded as the most sacred place for all the Hindus around the world worshipping Lord Shiva. The temple is located in the suburbs of Kathmandu city which is inscribed as world heritage site by UNESCO in 1979. Likewise, in Suryabinayak temple people worship God Ganesh whereas in Dakshinkali worshipping Goddess Dakshinkali. Swyambhunath is one of the holiest chaityas for Buddhism located in the northwest of the Kathmandu city. It is recognized as world heritage site by UNESCO in 1997. It is well-known as 'The Monkey Temple' among the tourists due to large number of primates living there. The three forest types- Schima-Pyrus Forest, Myrsine-Persea Forest and Quercus-Myrsine Forest highly dominated the PSF [30]. Likewise, the vegetation- *Pinus roxburghii*, *Schima wallichii*, *Ulnus nepalensis* etc. dominated the hills of SSF, DSF and SwSF.

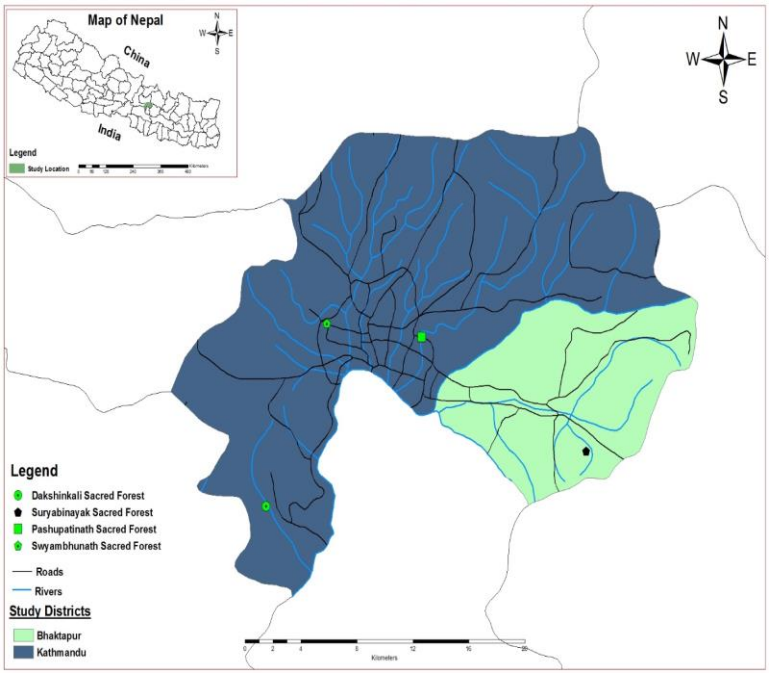

Fig 1: Showing four studied sacred forests of Kathmandu valley.

Field Visit

Field visit was carried out throughout the year 2017. Each site was visited three days in a week in every month. The time of field visit was made 7:00 hr-12:30 hr.

Data Collection

The line transect of 200-300 m distance was established from edge of the forest to the forest interior for data collection. Preexisting human trail was also followed for alternative data collection. Ocular observation was adopted during data collection whereas, confused butterflies were captured by butterfly net, then identified coinciding with literatures grids [31] and released. Data of tree preferring butterflies were collected by observing binocular. Killing for collection was strictly avoided during the study period. The status of butterfly species was made on the basis of abundance encountered during the study period. The status of recorded butterflies were categorized into four categories; 1-2 abundance-Very Rare (VR), 3-10 abundance- Rare (R), 11-30 abundance-Fairly Common (FC) and 30< abundance-Common (C) [35, 36].

Data Analysis

The data were statistically analyzed using Microsoft Excel, 2013. Species diversity of particular sites is calculated using Shannon Diversity Index (H'). We also calculate evenness of the species to reveals the relative abundance of species distributed in a particular sites using Pielou's Evenness Index (Equitability) (J').

$H' = -\sum (Pi \ln Pi)$

Where, Pi is the proportion of i^{th} species in total sample

$J' = H'/\ln S$

Where, lnS is the natural logarithm of the species richness. The value of J ranges from 0 to 1. Near the value of J to 1, lesser the variation in communities between the species.

Results

Altogether 2809 individuals of 77 butterfly species belonging to 56 genera and six families were registered during the study period from the four sacred forests of Kathmandu valley (Table 1). We noted Nymphalidae was the pre-dominant family contributing 37 species of 26 genera followed by Lycaenidae (12 species of 11 genera), Pieridae (11 species of 6 genera), Hesperiidae (8 species of 8 genera), Papilionidae (7 species of 4 genera) and Riodinidae (2 species of 1 genus) (Table 1). Also on the basis of abundance Nymphalidae dominated the collection (1657 individuals) then followed by Pieridae (434 individuals), Lycaenidae (378 individuals), Hesperiidae and Papilionidae (139 individuals each), and Riodinidae (66 individuals) (Table 1). Abundance of the butterfly species of the four sites is provided in Table 1. Nymphalidae butterflies dominated the all four sacred forests (Fig. 2). The eight butterfly species namely *Acytolepsis puspa*, *Zizeeria maha*, *Junonia iphita*, *Neptis hylas*, *Danaus genutia*, *Aglais cashmerensis*, *Pieris canidia* and *Eurema hecabe* were recorded from all four sacred forests (Table 1). *Pieris canidia* (188 individuals) was the highest abundant butterfly recorded during the survey. The maximum diversity

and evenness of distribution of butterfly species was observed in SSF (H'=3.8757 and J'=0.9365) whereas the minimum in PSF (H'= 2.2611 and J'=0.8564). Table 6 shows the values of Shannon Index and Pielou's Evenness Index of four studied scared forests. A detail composition of diversity and status of butterfly at different sacred forest are given below;

Suryabinayak Sacred Forest (SSF)

This sacred forest contributed highest butterfly abundance and richness. We recorded 1100 individuals of 62 species under 44 genera and six families. Family Nymphalidae registered the highest butterfly species richness (33 species; 24 genera) which was followed by Lycaenidae (11 species; 10 genera), Pieridae (8 species; 3 genera), Hesperiidae and Papilionidae (4 species each with 4 and 2 genera respectively) and Riodinidae (2 species; 1 genus) (Table 2). It comprises 79.22% of the total recorded species. On the basis of number of individual of the species observed, we registered only four species namely *Neptis cartica*, *Celastrina huegelii*, *Arhopala atrax*, and *Sephisa Chandra* were very rare, 19 species rare, 21 fairly common and 18 common in SSF (Table 2). The species wise status of butterflies along with their abundance of SSF are provided in Table 2. 12 butterfly species (*Spindasis syama*, *Spindasis lohita*, *Celastrina huegelii*, *Arhopala atrax*, *Ypthima nareda*, *Hestina nama*, *Tanaecia julii*, *Euthalia patala*, *Neptis cartica*, *Euploea mulciber*, *Eurema laeta* and *Dalias eucharis*) were recorded only from the SSF (Table 2).

Dakshinkali Sacred Forest (DSF)

A total 1092 individuals of 57 butterfly species belonging to 44 genera and six families were recorded from the DSF (Table 3), contributing the second highest butterfly abundance and species richness, which account 74.03% of total recorded butterfly species. DSF was dominated by Nymphalid butterflies (28 species; 21 genera) followed by Pierid (8 species; 6 genera), Lycaenid, and Papilionid butterflies contributing seven species from each under seven, and four genera respectively, Hesperiids (5 species; 5 genera) and Riodinid (2 species; 1 genus) was recorded least (Table 3). Number of individual of the butterfly species recorded suggest that, four species (*Notocrypta curvifascia*, *Colias fieldii*, *Papilio bianor* and *Atrophenura polyeuctes*) very rare, 15 species rare, 18 fairly common and 20 common from the DSF (Table 3). The species wise status and abundance of butterflies of DSF is given in Table 3. Throughout the study period, 11 buuterfly species namely; *Udaspes folus*, *Notocrypta curvifascia*, *Synatarucus plinius*, *Junonia orithya*, *Kaniska canace*, *Lethe confuse*, *Pontia daplidice*, *Colias fieldii*, *Papilio bianor*, *Atrophenura polyeuctes* and *Pachliopta hector* were recorded only from the DSF (Table 3).

Swyambhunath Sacred Forest (SwSF)

A total 461 individuals of 29 butterfly species belonging to 26 genera and five families were recorded from SwSF (Table 4). Family Riodinidae was completely absent from this sacred forest (Fig 2). This sacred forest constituted 37.66% of the total recorded species. The member of Nymphalide family represented by highest number (15 species; 14 genera) followed by Lycaenidae and Pieridae (5 species from each under 5 and 3 genera respectively), Hesperiidae (3 species; 3 genera) and Papilionidae (1 species; 1 genus) (Table 4). On the basis of butterfly abundance, the status of five species (*Coladenia indrani*, *Pseudocoladenia dan*, *Libythea myrrha*, *Vagrans egista* and *Appias lyncida*) were very rare, nine rare, eight fairly common and seven common from the SwSF. A detail status of butterfly species with number of individuals of butterfly recorded from SwSF is provided in Table 4. Three species viz. *Coladenia indrani*, *Pseudocoladenia dan* and *Libythea myrrha* were recorded only from the SwSF (Table 4).

Pashupatinath Sacred Forest (PSF)

This sacred forest contributed least abundance and species richness with 156 number of individuals of 14 butterfly species respectively belonging to 14 genera and five families (Table 5). Here also, family Riodinidae was completely absent (Fig 2). The forest contributed only 18.2% of the total recorded species. In PSF, butterfly species of family Nymphalidae (8 species of 8 genera) found dominated which was followed by Lycaenidae and Pieridae (2 species of 2 genera of each) and Hesperiidae and Papilionidae (1 species of 1 genus of each) (Table 5). Number of individual of the species recorded suggest that four species (*Potanthus pseudomaesa*, *Cupha erymanthis*, *Sephisa Chandra* and *Vagrans egista*) were very rare, three rare, six fairly common and one common from the PSF (Table 5). Status and abundance of recorded butterfly species of PSF are provided in Table 5. Even a single species was recorded from only PSF.

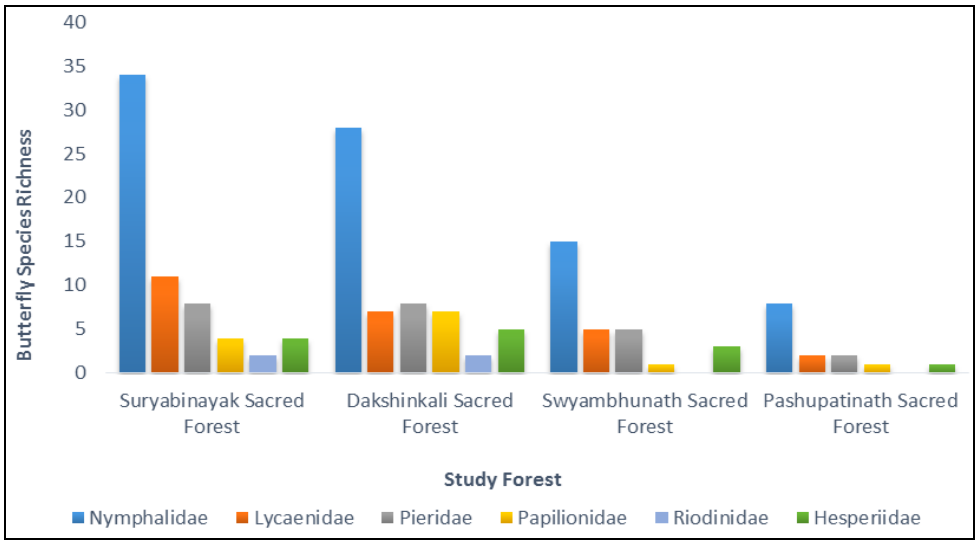

Fig 2: Family wise composition of Butterfly Species Richness in Four Sacred Forests.

Table 1: A checklists of butterflies with the number of individuals counted at four sacred forests. (T=Total; ST=Sum Total of the Families).

SN	Family/Common Name	Scientific Name	DSF	SwSF	PSF	SSF	T	ST
A.	**Hesperiidae**							
1	Straight Swift	*Parnara guttata*	13	-	-	13	26	135
2	Bevan Swift	*Borbo bevani*	7	-	-	4	11	
3	Common Small Flat	*Sarangesa dasahara*	31	22	-	31	84	
4	Tricoloured Pied Flat	*Coladenia indrani*	-	1	-	-	1	
5	Fulvus Pied Flat	*Pseudocoladenia dan*	-	1	-	-	1	
6	Grass Demon	*Udaspes folus*	2	-	-	-	2	
7	Restricted Demon	*Notocrypta curvifascia*	5	-	-	-	5	
8	Indian Dart	*Potanthus pseudomaesa*	-	-	1	4	5	
B.	**Lycaenidae**							
9	Club Silverlines	*Spindasis syama*	-	-	-	5	5	378
10	Long-banded Silverlines	*Spindasis lohita*	-	-	-	5	5	
11	Common Hedge Blue	*Acytolepsis puspa*	32	17	8	33	90	
12	Large Hedge Blue	*Celastrina huegelii*	-	-	-	1	1	
13	Malayan	*Megisba malaya*	6	5	-	6	17	
14	Common Pierrot	*Castalius rosimon*	14	-	-	16	30	
15	Lesser Grass Blue	*Zizina Otis*	-	8	-	14	22	
16	Pale Grass Blue	*Zizeeria maha*	33	32	17	35	117	
17	Peablue	*Lampides boeticus*	33	-	-	22	55	
18	Zebra Blue	*Synatarucus plinius*	5	-	-	-	5	
19	Indian Oakblue	*Arhopala atrax*	-	-	-	2	2	
20	Common Cerulean	*Jamides celeno*	13	7	-	9	29	
C.	**Nymphalidae**							
21	Peacock Pansy	*Junonia almana*	13	-	-	17	30	1657
22	Chocolate Pansy	*Junonia iphita*	37	19	13	33	102	
23	Blue Pansy	*Junonia orithya*	6	-	-	-	6	
24	Lemon Pansy	*Junonia lemonias*	39	-	-	33	72	
25	Blue Admirral	*Kaniska canace*	4	-	-	-	4	
26	Large Threering	*Ypthima nareda*	-	-	-	10	10	
27	Common Fourring	*Ypthima huebneri*	16	8	-	21	45	
28	Common Fivering	*Ypthima baldus*	33	-	-	31	64	
29	Banded Tree Brown	*Lethe confuse*	21	-	-	-	21	
30	Common Forester	*Lethe insane*	4	-	-	5	9	
31	Common Evening Brown	*Melanitis leda*	36	-	-	17	53	
32	Jungle Brown	*Orsotrioena medus*	44	38	-	41	123	
33	Circe	*Hestina nama*	-	-	-	7	7	
34	Rustic	*Cupha erymanthis*	7	-	2	6	15	
35	Common Map	*Cyrestis thyodamas*	15	-	-	15	30	
36	Common Castor	*Ariadne merione*	34	11	-	35	80	
37	Grey Count	*Tanaecia lepidea*	13	-	-	12	25	
38	Common Earl	*Tanaecia julii*	-	-	-	7	7	
39	Common Baron	*Euthalia aconthea*	4	-	-	4	8	
40	Grand Duchess	*Euthalia patala*	-	-	-	14	14	
41	Great Eggfly	*Hypolimnas bolina*	15	7	-	18	40	
42	Common Sailer	*Neptis hylas*	37	40	15	39	131	
43	Plain Sailer	*Neptis cartica*	-	-	-	2	2	
44	Staff Sergeant	*Athyma selenophora*	7	-	-	8	15	
45	Common Jester	*Symbrenthia lilaea*	13	14	-	15	42	
46	Common Indian Crow	*Euploea core*	36	35	-	33	104	
47	Striped Blue Crow	*Euploea mulciber*	-	-	-	7	7	
48	Plain Tiger	*Danaus chrysippus*	27	22	-	32	81	
49	Common Tiger	*Danaus genutia*	32	32	11	37	112	
50	Glassy Tiger	*Parantica aglea*	16	6	-	5	27	
51	Indian Red Admiral	*Vanessa indica*	40	14	-	33	87	
52	Painted Lady	*Vanessa carduii*	33	-	-	23	56	
53	Indian Fritillary	*Argynnis hyperbius*	32	-	8	39	79	
54	Eastern Courtier	*Sephisa Chandra*	-	-	1	1	2	
55	Club Peak	*Libythea myrrha*	-	1	-	-	1	
56	Indian Tortoiseshell	*Aglasis cashmerensis*	42	35	23	39	139	
57	Vigrant	*Vagrans egista*	-	2	1	4	7	
D.	**Pieridae**							
58	Indian Cabbage White	*Pieris canidia*	52	48	37	51	188	434
59	Large Cabbage White	*Pieris brassicae*	-	7	-	4	11	
60	Bath White	*Pontia daplidice*	7	-	-	-	7	
61	Common Grass Yellow	*Eurema hecabe*	35	16	15	31	97	
62	Small Grass Yellow	*Eurema brigitta*	17	6	-	15	38	
63	Three-spot Grass Yellow	*Eurema blanda*	17	-	-	17	34	
64	Spotless Grass Yellow	*Eurema laeta*	-	-	-	15	15	
65	Common Jezabel	*Dalias eucharis*	-	-	-	14	14	
66	Red-spot Jezabel	*Dalias descombesi*	5	-	-	9	14	
67	Chocolate Albatross	*Appias lyncida*	13	2	-	-	15	
68	Dark Clouded Yellow	*Colias fieldii*	1	-	-	-	1	
E.	**Papilionidae**							
69	Common Mormon	*Papilio polytes*	31	5	-	31	67	139
70	Great Mormon	*Papilio memnon*	3	-	-	5	8	
71	Spangle	*Papilio protenor*	9	-	-	14	23	
72	Common Peacock	*Papilio bianor*	2	-	-	-	2	
73	Common Windmill	*Atrophenura polyeuctes*	9	-	-	-	9	
74	Common Rose	*Pachliopta hector*	1	-	-	-	1	
75	Glassy Bluebottle	*Graphium cloanthus*	12	-	4	13	29	
F.	**Riodinidae**							
76	Mixed Punch	*Dodona ouida*	17	-	-	25	42	66
77	Orange Punch	*Dodona egeon*	11	-	-	13	24	
Grand Total Abundance								2809

Table 2: Status of Butterfly Species at Suryabinayak Sacred Forest.

SN	Family/Common Name	Scientific Name	Abundance	Status
A.	**Hesperiidae**			
1	Straight Swift	*Parnara guttata*	13	FC
2	Bevan Swift	*Borbo bevani*	4	R
3	Common Small Flat	*Sarangesa dasahara*	31	C
4	Indian Dart	*Potanthus pseudomaesa*	4	R
B.	**Lycaenidae**			
5	Club Sillverlines	*Spindasis syama**	5	R
6	Long-banded Silverlines	*Spindasis lohita**	5	R
7	Common Hedge Blue	*Acytolepsis puspa*	33	C
8	Large Hedge Blue	*Celastrina huegelii**	1	VR
9	Malayan	*Megisba Malaya*	6	R
10	Common Pierrot	*Castalius rosimon*	16	FC
11	Lesser Grass Blue	*Zizina Otis*	14	FC
12	Pale Grass Blue	*Zizeeria maha*	35	C
13	Peablue	*Lampides boeticus*	22	FC
14	Indian Oakblue	*Arhopala atrax**	2	VR
15	Common Cerulean	*Jamides celeno*	9	R
C.	**Nymphalidae**			
16	Peacock Pansy	*Junonia almana*	17	FC
17	Chocolate Pansy	*Junonia iphita*	33	C
18	Lemon Pansy	*Junonia lemonias*	33	C
19	Large Threering	*Ypthima nareda**	10	R
20	Common Fourring	*Ypthima huebneri*	21	FC
21	Common Fivering	*Ypthima baldus*	31	C
22	Common Evening Brown	*Melanitis leda*	17	FC
23	Common Forester	*Lethe insane*	5	R
24	Jungle Brown	*Orsotrioena medus*	41	C
25	Circe	*Hestina nama**	7	R
26	Rustic	*Cupha erymanthis*	6	R
27	Common Map	*Cyrestis thyodamas*	15	FC
28	Common Castor	*Ariadne merione*	35	C
29	Grey Count	*Tanaecia lepidea*	12	FC
30	Common Earl	*Tanaecia julii**	7	R
31	Common Baron	*Euthalia aconthea*	4	R
32	Grand Duches	*Euthalia patala**	14	FC
33	Great Eggfly	*Hypolimnas bolina*	18	FC
34	Common Sailer	*Neptis hylas*	39	C
35	Plain Sailer	*Neptis cartica**	2	VR
36	Staff Sergeant	*Athyma selenophora*	8	R
37	Common Jester	*Symbrenthia lilaea*	15	FC
38	Common Indian Crow	*Euploea core*	33	C
39	Striped Blue Crow	*Euploea mulciber**	7	R
40	Common Tiger	*Danaus genutia*	37	C
41	Plain Tiger	*Danaus chrysippus*	32	C
42	Glassy Tiger	*Parantica aglea*	5	R
43	Indian Red Admiral	*Vanessa indica*	33	C
44	Painted Lady	*Vanessa carduii*	23	FC
45	Indian Fritillary	*Argynnis hyperbius*	39	C
46	Eastern Courtier	*Sephisa chandra*	1	VR
47	Indian Tortoiseshell	*Aglasis cashmerensis*	39	C
48	Vigrant	*Vagrans egista*	4	R
D.	**Pieridae**			
49	Indian Cabbage White	*Pieris canidia*	51	C
50	Large Cabbage White	*Pieris brassicae*	4	R
51	Common Grass Yellow	*Eurema hecabe*	31	C
52	Small Grass Yellow	*Eurema brigitta*	15	FC
53	Three-spot Grass Yellow	*Eurema blanda*	17	FC
54	Spotless Grass Yellow	*Eurema laeta**	15	FC
55	Common Jezabel	*Dalias eucharis**	14	FC
56	Red-spot Jezabel	*Dalias descombesi*	9	R
E.	**Papilionidae**			
57	Common Mormon	*Papilio polytes*	31	C
58	Great Mormon	*Papilio memnon*	5	R
59	Spangle	*Papilio protenor*	14	FC
60	Glassy Bluebottle	*Graphium cloanthus*	13	FC
F.	**Riodinidae**			
61	Mixed Punch	*Dodona ouida*	25	FC
62	Orange Punch	*Dodona egeon*	13	FC
Total Abundance			1100	

Note: * Indicates butterfly species recorded only in Suryabinayak Sacred Forest

Table 3: Status of Butterfly Species at Dakshinkali Sacred Forest.

SN	Family/Common Name	Scientific Name	Abundance	Status
A.	**Hesperiidae**			
1	Straight Swift	*Parnara guttata*	13	FC
2	Bevan Swift	*Borbo bevani*	7	R
3	Common Small Flat	*Sarangesa dasahara*	31	C
4	Restricted Demon	*Notocrypta curvifascia*[*]	2	VR
5	Grass Demon	*Udaspes folus*[*]	5	R
B	**Lycaenidae**			
6	Common Hedge Blue	*Acytolepsis puspa*	32	C
7	Malayan	*Megisba Malaya*	6	R
8	Common Pierrot	*Castalius rosimon*	14	FC
9	Pale Grass Blue	*Zizeeria maha*	33	C
10	Peablue	*Lampides boeticus*	33	C
11	Zebra Blue	*Synatarucus plinius*[*]	5	R
12	Common Cerulean	*Jamides celeno*	13	FC
C.	**Nymphalidae**			
13	Peacock Pansy	*Junonia almana*	13	FC
14	Chocolate Pansy	*Junonia iphita*	37	C
15	Blue Pansy	*Junonia orithya*[*]	6	R
16	Lemon Pansy	*Junonia lemonias*	39	C
17	Common Fourring	*Ypthima huebneri*	16	FC
18	Common Fivering	*Ypthima baldus*	33	C
19	Banded Tree Brown	*Lethe confuse*[*]	21	FC
20	Common Evening Brown	*Melanitis leda*	36	C
21	Common Forester	*Lethe insane*	4	R
22	Jungle Brown	*Orsotrioena medus*	44	C
23	Rustic	*Cupha erymanthis*	7	R
24	Common Map	*Cyrestis thyodamas*	15	FC
25	Common Castor	*Ariadne merione*	34	C
26	Grey Count	*Tanaecia lepidea*	13	FC
27	Common Baron	*Euthalia aconthea*	4	R
28	Great Eggfly	*Hypolimnas bolina*	15	FC
29	Common Sailer	*Neptis hylas*	37	C
30	Staff Sergeant	*Athyma selenophora*	7	R
31	Common Jester	*Symbrenthia lilaea*	13	FC
32	Common Indian Crow	*Euploea core*	36	C
33	Common Tiger	*Danaus genutia*	32	C
34	Plain Tiger	*Danaus chrysippus*	27	FC
35	Glassy Tiger	*Parantica aglea*	16	FC
36	Indian Red Admiral	*Vanessa indica*	40	C
37	Painted Lady	*Vanessa carduii*	33	C
38	Indian Fritillary	*Argynnis hyperbius*	32	C
39	Indian Tortoiseshell	*Aglasis cashmerensis*	42	C
40	Blue Admiral	*Kaniska canace*[*]	4	R
D.	**Pieridae**			
41	Indian Cabbage White	*Pieris canidia*	52	C
42	Bath White	*Pontia daplidice*[*]	7	R
43	Common Grass Yellow	*Eurema hecabe*	35	C
44	Small Grass Yellow	*Eurema brigitta*	17	FC
45	Three-spot Grass Yellow	*Eurema blanda*	17	FC
46	Red-spot Jezabel	*Dalias descombesi*	5	R
47	Dark Clouded Yellow	*Colias fieldii*[*]	1	VR
48	Chocolate Albatross	*Appias lyncida*	13	FC
E.	**Papilionidae**			
49	Common Mormon	*Papilio polytes*	31	C
50	Great Mormon	*Papilio memnon*	3	R
51	Spangle	*Papilio protenor*	9	R
52	Common Peacock	*Papilio bianor*[*]	2	VR
53	Common Windmill	*Atrophenura polyeuctes*[*]	9	R
54	Common Rose	*Pachliopta hector*[*]	1	VR
55	Glassy Bluebottle	*Graphium cloanthus*	12	FC
F.	**Riodinidae**			
56	Mixed Punch	*Dodona ouida*	17	FC
57	Orange Punch	*Dodona egeon*	11	FC
Total Abundance			1092	

Note: * Indicates butterfly species recorded only in Dakshinkali Sacred Forest

Table 4: Status of Butterfly Species at Swyambhunath Sacred Forest.

SN	Family/Common Name	Scientific Name	Abundance	Status
A	**Hesperiidae**			
1	Common Small Flat	*Sarangesa dasahara*	22	FC
2	Tricoloured Pied Flat	*Coladenia indrani**	1	VR
3	Fulvus Pied Flat	*Pseudocoladenia dan**	1	VR
B.	**Lycaenidae**			
4	Common Hedge Blue	*Acytolepsis puspa*	17	FC
5	Malayan	*Megisba Malaya*	5	R
6	Lesser Grass Blue	*Zizina Otis*	8	R
7	Pale Grass Blue	*Zizeeria maha*	32	C
8	Common Cerulean	*Jamides celeno*	7	R
C.	**Nymphalidae**			
9	Chocolate Pansy	*Junonia iphita*	19	FC
10	Common Fourring	*Ypthima huebneri*	8	R
11	Jungle Brown	*Orsotrioena medus*	38	C
12	Common Castor	*Ariadne merione*	11	FC
13	Club Peak	*Libythea myrrha**	1	VR
14	Great Eggfly	*Hypolimnas bolina*	7	R
15	Common Sailer	*Neptis hylas*	40	C
16	Common Jester	*Symbrenthia lilaea*	14	FC
17	Common Indian Crow	*Euploea core*	35	C
18	Common Tiger	*Danaus genutia*	32	C
19	Plain Tiger	*Danaus chrysippus*	22	FC
20	Glassy Tiger	*Parantica aglea*	6	R
21	Indian Red Admiral	*Vanessa indica*	14	FC
22	Indian Tortoiseshell	*Aglasis cashmerensis*	35	C
23	Vigrant	*Vagrans egista*	2	VR
D.	**Pieridae**			
24	Indian Cabbage White	*Pieris canidia*	48	C
25	Large Cabbage White	*Pieris brassica*	7	R
26	Common Grass Yellow	*Eurema hecabe*	16	FC
27	Small Grass Yellow	*Eurema brigitta*	6	R
28	Chocolate Albatross	*Appias lyncida*	2	VR
E.	**Papilionidae**			
29	Common Mormon	*Papilio polytes*	5	R
Total Abundance			461	

Note: * Indicates butterfly species recorded only in Swyambhunath Sacred Forest.

Table 5: Status of Butterfly Species at Pashupatinath Sacred Forest.

SN	Family/Common Name	Scientific Name	Abundance	Status
A.	**Hesperiidae**			
1	Indian Dart	*Potanthus pseudomaesa*	1	VR
B.	**Lycaenidae**			
2	Common Hedge Blue	*Acytolepsis puspa*	8	R
3	Pale Grass Blue	*Zizeeria maha*	17	FC
C.	**Nymphalidae**			
4	Chocolate Pansy	*Junonia iphita*	13	FC
5	Rustic	*Cupha erymanthis*	2	VR
6	Common Sailer	*Neptis hylas*	15	FC
7	Common Tiger	*Danaus genutia*	11	FC
8	Indian Fritillary	*Argyreus hyperbius*	8	R
9	Eastern Courtier	*Sephisa Chandra*	1	VR
10	Indian Tortoiseshell	*Aglasis cashmerensis*	23	FC
11	Vigrant	*Vagrans egista*	1	VR
D.	**Pieridae**			
12	Indian Cabbage White	*Pieris canidia*	37	C
13	Common Grass Yellow	*Eurema hecabe*	15	FC
E.	**Papilionidae**			
14	Glassy Bluebottle	*Graphium cloanthus*	4	R
Total Abundance			156	

Table 6: Shannon Diversity Index (H') and Pielou's Evenness Index (J) at four sacred forests

Study Sites	H'	J'
SSF	3.8757	0.9365
DSF	3.7732	0.9325
SwSF	3.0064	0.8939
PSF	2.2611	0.8564

Discussion

This is the first comprehensive study on butterflies at different sacred forests of Kathmandu valley. Although the butterfly survey was conducted in the Kathmandu valley in the past by Khanal and Smith (1997) [13] recorded 360 butterfly species. During the study period we had recorded 2809 individuals of

77 butterfly species. The recorded butterfly species of sacred forests represents 21.39% of the total species of Kathmandu valley. The family that recorded the highest abundance and species richness was Nymphaidae. Such dominance of Nymphalidae was also observed in Kathmandu valley by Khanal and Smith (1997) [13]. In the context of such sites similar abundance and richness patterns of butterfly was obtained from Abiriw and Odumante sacred groves in the Eastern Region of Ghana [12] and sacred groves of Goa, India [5]. *Pieris canidia* represented the highest abundant butterfly species constituted 6.5% of total recorded individual whereas the *Aglais cashmerensis* was the second highest abundant butterfly which constituted 4.95% of the total butterfly individual. Arya *et al*. (2014) [1] also recorded *A. cashmerensis* as the second abundant butterfly species after *Pieris brassicae nepalensis* in and around Kumaun University, Nainital, Uttarakhand, India, whereas we recorded only 11 individuals of *Pieris brassicae* from two sites (SwSF (7 individuals) and SSF (4 individuals)) and recognized as rare. However, the species was found common by Khanal (2008) [14] in lowland districts of west Nepal and absent in the central part of Koshi Tappu Wildlife Reserve, Eastern Nepal [15].

SSF and DSF recorded the maximum abundance, species richness, species diversity (H'=3.8757 and 3.7732 respectively) and relatively high evenness in species distribution (J'=0.9365 and 0.9325 respectively) with individuals evenly distributed among the different species. In most habitat, plant communities have considerable influence on the distribution of animal species [19]. Generally, both the sacred forests host high plant diversity along with sufficient availability of nectar and food plants for butterflies. This support the high butterfly abundance and richness from both the sacred forests. Similar finding of maximum butterflies presence in the high plant diversity sites was obtained by Sulton *et al*. (1991) [32], Majumder *et al*. (2013) [23], Arya *et al*. (2014) [1] Sharma *et al*. (2014) [28], and Gaude and Janarthanam (2015) [9]. Moreover, both the sacred forests are surrounded by adjacent landscapes such as agricultural land that provides suitable habitat for maximum butterflies. As we observed the frequent visiting of butterflies from such landscapes to the forests. This behavior of butterflies is consistent with that of Emmel and Leck (1969) [6], and Gaude and Janarthanam (2015) [9]. Interestingly, the adjoining grassland of the forests did not favour the high species richness as finding of Kunte (2001) [18], Tiple *et al*. (2007) [33] and Gaude and Janarthanam (2015) [9]. However some butterflies species such as *Zizeeria maha*, *Lampides boeticus* and *Acytolepsis puspa* were recorded maximum from such area. These species had more intense peaks at such land for egg-laying behaviour and hence observed in drier seasons. For instance, both the sacred forests are being used for recreational activities like picnic, hiking, filming etc. [11]. Such activities disturbed the foraging behavior of butterflies in and around the forests (Nganso *et al*. 2012) [21]. Nevertheless, overall butterfly richness in the forests were comparatively high. SwSF and PSF has relatively very less butterfly abundance and richness. Both the sacred forests are underrated by maximum human encroachment and unmanaged pollution because the forests lie within the rural gradient and near major roads [11]. This facts provide less butterfly number from the forests and is consistent with other studies which found that the number of butterfly species decreased substantially with increasing anthropization [2, 8, 14, 17, 26]. In contrast, Kunte (2001) [18], Tiple *et al*. (2006) [33], Tiple and Khurad (2009) [34], and Arya *et al*. (2014) [1] revealed the increased species richness in high human impacted sites. Surprisingly, three species (*Coladenia indrani*, *Pseudocoladenia dan* and *Libythea myrrha*) were exclusively represented the SwSF. However they were occurred very rare (1 individual) (Table 4). Moreover, in case of PSF, out of 14 species recorded only one species (*Pieris canidia*; Family: Pieridae) was found common (Table 5). This clearly suggest the conservation importance of both the forests. Less availability of nectars and larval food plants in both sacred forests might be another reason of sighting less butterfly richness. Many previous studies obtained the similar patterns of butterflies in less available nectar food plants [5, 22, 27, 33]. However, the presence of invasive shrub species like *Lantana camara* at surrounding gave food plants efficiency to the butterflies throughout the year which coincided in finding of Nimbalkar *et al*. (2011) [22]. In overall, all study sites had provided minimum number of butterfly abundant and richness during dry season. Dry ground cover, high temperature, dry food plants etc. might be possible reason of less sighting of butterflies in such period [18].

In the course of the study period we also followed the human trail for the opportunistic survey of butterflies. We listed least abundance and richness of butterfly in human trail. Butterflies of SwSF and PSF were found seriously affected by this human trail as both the sacred sites possess number of open access tracks. However, the butterflies of families Nymphalidae and Pieridae were found fairly common as Gonzalez *et al*. (2017) [10] also sighted such patterns of butterflies on tourism trails of northeast Portugal. If the limited tracks were allowed for human trail, the abundance and butterfly richness may increase in both the sacred forests. Hence such threats to butterflies should be addressed in time. Moreover, the local forest conservation committees, local clubs, and government should strict to organize the picnic, hiking and other human activities within the forests for sustainable conservation of butterfly species.

Conclusion

The present study concluded that that the maximum plant diversity with availability of sufficient nectars and food plants always favour the high butterfly diversity. Moreover, this study also revealed that human stress sites are noticeably recognized as relatively disturbed area that directly effect on the butterfly abundance and richness. This is the first study on butterflies in sacred forests but there is lots more sacred forests remain throughout the country where research efforts is still not reached yet. Hence in order to explore the diversity and conservation status of butterflies from such forests extensive and intensive research work is very much important. In addition, it is important to aware people about conservation important and habitat management of butterflies as they are the good indicators of environment.

Acknowledge

The authors are very much grateful to IDEA WILD, USA for equipment support for this research. We also very much thankful to Mr. Neil Subedi and Mr. Sitaram Awasti for their kind support in field survey period.

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