



DIVERSITY OF BUTTERFLY POLLINATORS IN AGROECOSYSTEMS OF KUMAUN REGION

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ABSTRACT

This study examined the diversity, abundance and evenness of butterfly pollinators in Kumaun region, Uttarakhand from March 2019 to February 2020. A total of 394 butterflies, representing 40 species and five families were collected. Nymphalidae was the most dominant family with 19 species, followed by Pieridae (9 species), Lycaenidae (9 species), Papilionidae (2 species), and Hesperidae (1 species), respectively. *Pieris canidia indica* (Evans) was the most abundant species, constituting 38.3% of the total individuals. Shannon-Wiener diversity index was observed to be maximum in Site-1 ($H' = 1.37$) than in Site-2 ($H' = 1.12$). Similarly, evenness was maximum in Site-1 ($E = 0.457$), than in Site-2 ($E = 0.333$). In addition, significant pollinator species in crops have been identified in agroecosystems.

Key words: Lepidoptera, agroecosystem, species richness, evenness, distribution, abundance, pollination, species composition, diversity indices, *Pieris canidia indica*

Insects are the most dominating and diverse organisms on earth, inhabit all habitat types and play major roles in the function and stability of terrestrial and aquatic ecosystems (Godfray, 2002). Slightly over one million of insect species have been described, of which five insect orders stand out to be the most abundant in their levels of species richness: Hymenoptera, Diptera, Coleoptera, Lepidoptera, and the Hemiptera (Jach and Balke, 2008). The Lepidoptera with >1,50,000 species is the second largest and the most diverse (Risley, 1986; Gullan and Cranston, 2010). Butterflies are generally colorful winged insects with an overlay of tiny scales, and thus, butterflies are the planet's most majestic creatures with brilliantly colored and exquisitely patterned (Mayur et al., 2013). They have always been fascinating (Kehimkar, 2008). Butterflies are one of the best taxonomically studied groups of insects (Pollard, 1991; Robbins et al., 1997; Kunte, 2000). Pollinators play an immense role in producing many fruits, vegetables and field crops (Klein et al., 2007). Pollination not only improves the yield of the crop but also contributes to uniform and early pod setting (Abrol, 2007) which increase production (Aizen et al., 2008). Hymenoptera, Diptera, Coleoptera, Lepidoptera, Thysanoptera, Hemiptera and Neuroptera are of prime significance in the crop pollination (Free, 1993; Kearns et al., 1998; Bhowmik et al., 2014). Butterflies also play an important role in pollination (Patil et al., 2017; Martínez-Adriano et al., 2018). The relationship between flowering plants and flower-visiting insects is essential for conserving the terrestrial ecosystem and

leading to different interactions between insect-plant and insect-herbivore (Soler et al., 2009). Tiple (2011) reported a total of 1504 lepidopterans from the Indian Subcontinent. There are only a few studies reported on diversity of butterflies in Kumaun region (Tyagi et al., 2011; Gariya 2016; Arya 2020). The present study aims at finding out the species composition, distribution and status of butterflies in the agroecosystems of Paharpani and Betalghat, Nainital, Kumaun region, Uttarakhand.

MATERIALS AND METHODS

The present study was conducted in agroecosystems located at Paharpani (2044 masl, 29° 25' 38N, 79° 42' 41E), Betalghat (774 masl, 29° 33' 20N, 79° 20' 51E) in Nainital district of Uttarakhand from March 2019 to February 2020. In Paharpani, (*Brassica oleracea*) L., (*Brassica sinapis*) L., (*Coriandrum sativum*) L., (*Solanum tuberosum*) L., (*Cucumis sativus*) L., (*Pisum sativum*) L., (*Allium cepa*) L., (*Raphanus sativus*) L., (*Phaseolus vulgaris*) L., (*Capsicum annum*) L., (*Phaseolus vulgaris*) L., (*B. oleracea*) L. are grown. In Betalghat, (*S. tuberosum*) L., (*Brassica sinapis*) L., (*P. sativum*) L., (*Abelmoschus esculentus*) L., (*A. cepa*) L., (*Coriandrum sativum*) L., (*B. oleracea*) Var. batrytis., (*Cucurbita pepo*) L., (*S. melongena*) L., (*Solanum lycopersicum*) L. are grown. Sites were visited regularly on monthly basis between 9:00 am to 2:00 pm, when the butterflies were most active. Sampling of butterflies was done at an interval of 30 days. The butterflies were collected by sweep method and hand picking. The sweep net with a diameter of 30 cm at the mouth

Table 1. Species of butterflies (Paharpani and Betalghat, Kumaun region, Nainital, Uttarakhand).

S. No.	Species	Common name	Site-1	Site-2	Total
Family: Pieridae					
1.	<i>Pieris canidia indica</i> (E)	Indian cabbage white	15	30	45
2.	<i>Pontia daplidice</i> (L)	Bath white	8	12	20
3.	<i>Eurema brigitta rubella</i> W	Small grass yellow	-	28	28
4.	<i>Eurema laeta</i> B	Spotless grass yellow	-	4	4
5.	<i>Goneptyryx rhamni nepalensis</i> D	Common brimstone	8	4	12
6.	<i>Aporia agathon</i> (G)	Great blackvein	6	5	11
7.	<i>Colias felidi</i> M	Dark clouded yellow	13	7	20
8.	<i>Catopsilia pyranthe</i> L	Mottled emigrant	-	7	7
9.	<i>Pareronia hippia</i> F	Indian wanderer	-	4	4
Family: Nymphalidae					
10.	<i>Vanessa indica</i> H	Indian red admiral	-	4	4
11.	<i>Vanessa cardui</i> L	Painted lady	-	3	3
12.	<i>Aglais caschmirensis</i> K	Indian tortoiseshell	12	18	30
13.	<i>Junonia lemmonias</i> L.	Lemon pansy	-	7	7
14.	<i>Junonia ipitha</i> C	Chocolate pansy	-	2	2
15.	<i>Neptis hylas</i> L	Common sailor	-	4	4
16.	<i>Ypthima inica</i> H	Lesser three ring	5	-	5
17.	<i>Ypthima baldus</i> F	Common five ring	-	3	3
18.	<i>Callerebia scanada</i> K	Pallid argus	8	2	10
19.	<i>Callerebia nirmala</i> M	Common argus	5	-	5
20.	<i>Collerebia hybrida</i> B	Hybrid argus	-	4	4
21.	<i>Acraea issoria</i> H	Yellow coster	7	-	7
22.	<i>Ariadne merione</i> C	Common castor	-	4	4
23.	<i>Hypolimnas bolina</i> (L)	Great eggfly	-	1	1
24.	<i>Lasiommata schakra</i> K	Common wall	8	-	8
25.	<i>Euthalia patala</i> K	Common baron	-	3	3
26.	<i>Lethe rohria</i> F	Common treebrown	-	2	2
27.	<i>Danaus chrysippus</i> L	Plain tiger	-	6	6
28.	<i>Parantica aglea</i> S	Glassy tiger	-	2	2
Family: Lycaenidae					
29.	<i>Lycaena pavana</i> K	White bordered copper	24	-	24
30.	<i>Lycaena phlaeas</i> L	Common copper	-	3	3
31.	<i>Euchrysops cnejus</i> F	Gram blue	4	-	4
32.	<i>Heliophorus moorei</i> (H)	Azure sapphire	9	-	9
33.	<i>Dodona durga</i> K	Common punch	8	-	8
34.	<i>Talicauda nyseus</i> (G)	Red pierrot	-	6	6
35.	<i>Zizeeria sp.</i>		20	12	32
36.	<i>Pseudozizeeria maha</i> K	Pale grass blue	9	-	9
37.	<i>Zizina otis</i> F	Lesser grass blue	10	-	10
Family: Papilionidae					
38.	<i>Papilio demoleus</i> L	Lime butterfly	-	2	2
39.	<i>Papilio polytes</i> L	Common Mormon	8	12	20
Family: Hesperidae					
40.	<i>Borbo bevani</i> M	Bevan's swift	6	-	6
	Total		193	201	394

and the bag length of 60 cm was used. The collected butterflies were killed with ethyl acetate soaked cotton and brought to the laboratory, processed and stretched in wooden boxes. The collected specimens were identified through various standard literatures. (Kumar, 2008; Singh, 2011). Biodiversity indices were calculated following Shannon-Wiener (1963) and evenness index (Hill, 1973).

RESULTS AND DISCUSSION

During the present study, a total of 40 species of butterflies belonging to 5 families were collected (Table 1; Figs. 1-9). Out of these, nine species each belonged to the families Pieridae and Lycaenidae, 19 species to Nymphalidae, two species to Papilionidae and one species to family Hesperidae. A total of 20 species were collected from site-1 and 29 species from site-2. Maximum species belonged to Pieridae (38.3%) and Nymphalidae (27.9%). A total of 394 individuals of butterflies were collected in two study sites: 193 individuals belonged from site-1 and 201 individuals from site-2. In terms of number of species, family Nymphalidae was the most dominant with 19 species (47.5%) followed by Pieridae and Lycaenidae (9 species, 22.5%) in each, Papilionidae (2 species, 5%) and Hesperidae (1 species, 2.5%). Relative abundance (%) of individuals of different families are shown in Fig. 1. Overall, maximum number of individuals belonged to the Pieridae (151 individuals, 38.3%).

Temperate region of Nainital, Kumaun region, Uttarakhand commonly consists of different crops and vegetables. Different workers have documented the study of butterflies in different parts of the Nainital district (Tyagi et al., 2011; Kapkoti et al., 2016; Arya

et al., 2017; Meena et al., 2017; Sanwal et al., 2017). The present study showed that the pollinators diversity was more in Paharpani, having more varied vegetation type and floral vegetation in comparison to Betalghat. Our findings clearly indicated that all 40 species of butterflies collected were the most diverse pollinators in the agro-ecosystem studied. The large body of butterflies helps in sticking of pollens to their legs and proboscis when they visit another flower thus making butterflies a very effective pollinator of crops (Duara and Kalita, 2013; Rader et al., 2016; Das et al., 2018). Diversity indices provide important information about rarity and commonness of species bin a community. Shannon index of diversity is considered to be the most complete measures of diversity because it takes into account both number of species and the abundance of each species. Shannon-Wiener's diversity index was higher in site-1 ($H' = 1.37$), than in site-2 ($H' = 1.12$). Similarly, Evenness was higher in site-1 ($E = 0.457$), than in site-2 ($E = 0.333$). The results obtained for diversity indices in the present study indicate that values obtained are comparable to other reported values for Lepidoptera in different agro-ecosystems (Arya et al., 2014, Usha and John, 2015).

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AUTHOR CONTRIBUTION STATEMENT

All authors equally contributed.

CONFLICT OF INTEREST

No conflict of interest.

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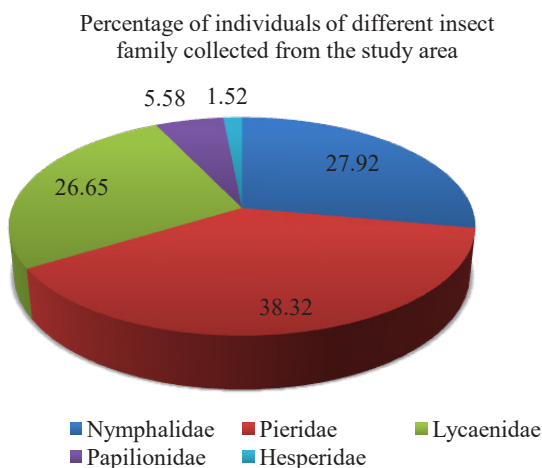


Fig. 1. Relative abundance (%) - families

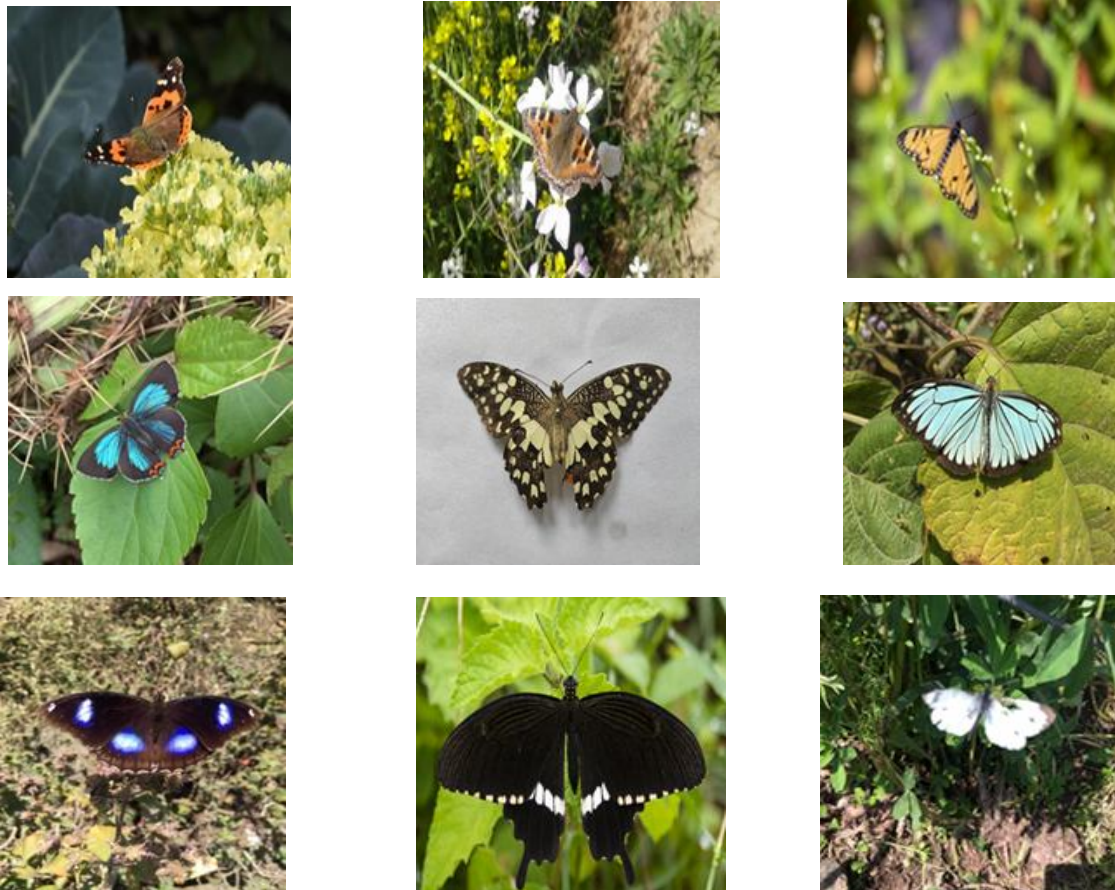


Fig. 2-10. Habitus of abundant butterflies: 1. *Vanesaa indica*; 2. *Aglaia cashmirensis*; 3. *Acraea issoria*; 4. *Heliophorus moorei*; 5. *Papilio demolus*; 6. *Pareronia hippia*; 7. *Hypolimnas bolina*; 8. *Papilio polytes*; 9. *Pieris canidia indica*

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