



E-ISSN: 2320-7078

P-ISSN: 2349-6800

JEZS 2018; 6(2): 2946-2953

© 2018 JEZS

Received: 16-01-2018

Accepted: 17-02-2018

Fasuil Farooq

Insect Biodiversity Laboratory,
Department of Zoology
D.S.B. Campus, Kumaun
University, Nainital,
Uttarakhand, India

Manoj Kumar Arya

Insect Biodiversity Laboratory,
Department of Zoology
D.S.B. Campus, Kumaun
University, Nainital,
Uttarakhand, India

Butterflies diversity in the temperate fruit tree orchards of Kumaun Himalaya, Uttarakhand, India

Fasuil Farooq and Manoj Kumar Arya

Abstract

The present study investigated the species richness, abundance and distribution of butterflies in the temperate fruit tree orchards of district-Nainital, Kumaun Himalaya, Uttarakhand, India and were carried out in three temperate fruit tree orchards from July 2016 to June 2017, located at Satbunga, Khabrar and orchards of Central Institute of Temperate Horticulture (CITH), Mukteshwar. A total of 1247 individuals of butterflies representing 33 species and 4 families were recorded during the course of study. Nymphalidae was the most dominant family and supported 17 species followed by Pieridae (9 species), Papilionidae (5 species) and Lycaenidae (2 species), respectively. Among the total species, *Catopsilia pomona* Fabricius was the most abundant species and constituted 13.71% of the total individuals followed by *Eurema hecabe* Linnaeus, *Pieris canidia* Sparrman and *Aglais cashmerensis* Kollar, respectively. Contrarily, *Graphium eurous* Leech was the least abundant species constituted 0.32% of the total individuals followed by *Neptis zaida* Doubleday and *Papilio machaon* Linnaeus. Shannon diversity index (H) was highest in the orchard of Central Institute of Temperate Horticulture- Mukteshwar (3.171) followed by Khabrar (3.001) and Satbunga (2.776). Evenness was highest in Satbunga (0.84) followed by Khabrar (0.80) and CITH (0.79). Similarly, Margalef's index was highest in CITH (4.547) followed by Khabrar (4.004) and Satbunga (3.244) respectively. Based on the number of sightings, 14 species were characterized as fairly common (FC) and accounted 42.42% of the total species, 15 species (45.45%) were characterized as common (C) and 4 species (12.12%) were uncommon (UC). During the present study, site having greater fruit trees (varieties) supported maximum species composition, richness and abundance of butterflies.

Keywords: Abundance, butterflies, diversity, family, species

1. Introduction

Butterflies are cosmopolitan and accounts more than 17000 species all over the world [17]. The Indian subcontinent hosts about 1504 species of butterflies [33], of which 323 species of butterflies from Uttarakhand are known [17]. Today several species of butterflies are regarded as indicator species by conservation biologist to identify habitats that are critical and needs to be protected. They are also monitored to indicate climatic change and environmental degradation as well, hence like other animals butterflies are now studied as living ecological component [15]. Beside this, butterflies play an important role in ecosystem as plant pollinator and in food chain as herbivores [34]. They are highly sensitive to environmental alterations so much that they have been considered as excellent bioindicators of climate [5, 6, 16, 25, 37, 38] and can be used as surrogate to assess the conservation threat of the biodiversity [28] and the abundance of butterflies usually indicate healthier ecosystem [35]. The diversity and abundance of butterfly species is associated with the availability of food plants in the surrounding habitat [20], consequently the lack of butterfly diversity is not entirely due to the climate but is more directly a result of low floral diversity leading to support greater butterfly diversity [11]. The change in the distribution and diversity of butterflies may reflect due to change in land use that leads landscape changes [1] and also acts as umbrella species (species whose protection serves to protect many co-occurring species) for management and protection planning [4, 7]. Butterflies are habitat specific and their diversity is restricted to different seasons [19, 23]. Different workers have documented the study of butterflies in different parts of Nainital district [2, 3, 9, 14, 22, 26, 29, 36]. Thus the present study aimed to explore the species composition, distribution and status of butterflies in the temperate fruit trees orchards of Nainital, Kumaun Himalaya, Uttarakhand.

Correspondence**Manoj Kumar Arya**

Insect Biodiversity Laboratory,
Department of Zoology
D.S.B. Campus, Kumaun
University, Nainital,
Uttarakhand, India

2. Materials and Methods

2.1 Study area

The present study was conducted in three temperate fruit tree orchards located in Nainital district of Uttarakhand state from July 2016 to June 2017. The selected study sites are rich in scenic beauty, with magnificent views of the Indian Himalayas including India's second highest peak, Nanda Devi. Because of the hilly topography, agriculture in the area

consists chiefly of potato fields and is bounded by fruit orchards on terraces cut into hilly sides surrounded by coniferous forests. The pattern of seasons is similar to that in other parts of northern India, with distinct summer, rainy and winter seasons. The three study sites were selected for the present study along with their characteristic attributes have been given in Table 1.

Table 1: Study sites and their characteristic features.

Site	Dominant fruit trees & their varieties
Site-1 (Satbunga) Altitude: 2177 m Location: 29°26.572'N 79°36.482'E	<i>Malus domestica</i> (Red Delicious Buhra- DK) <i>Pyrus communis</i> (Red Starkrimson)
Site-2(CITH- Mukteshwar) Altitude: 2235 m Location: 29°27.437'N 79°39.258'E	<i>Malus domestica</i> (Ambri Kashmiri; Golden Delicious; CITH Lodh Apple 1; Red Delicious; Red Spur; Chaubatia Princess; Oregon Spur Red Delicious) <i>Prunus persica</i> (Reliance; Red June; Golden Monarch; Florida king and Florida Sun) <i>Actinidia deliciosa</i> (Allison; Hayward and Tomury) <i>Prunus sp.</i> (Methley; Ramgarh Manard and Satsuma Plum)
Site-3 (Khabrar) Altitude: 2310 m Location: 29°26.382'N 79°35.947'E	<i>Malus domestica</i> (Red Delicious; Golden Delicious; Prima; Ambri Kashmiri; Chaubatia Anupam; Red Spur and Red Delicious Buhra) <i>Pyrus communis</i> (Yog and Red Starkrimson)

2.2 Methodology

2.2.1 Sampling and identification of butterflies:

Three fruit blocks (1 acre each measured by GPS, Garmin etrex 10) located at Satbunga, Central Institute of Temperate Horticulture (CITH) Mukteshwar and Khabrar of Ramgarh block were selected. The fruit blocks were selected on the basis of presence of dominant fruit trees (varieties) shown in Table 1. One permanent transect-line was set up at each site and the observations were taken out regularly on monthly basis between 9:00 am to 2:00 pm when the butterflies were most active. The insects were collected using sweep sampling method [8]. The collected insects were kept for short time into bottles containing Chloroform soaked cotton and identified with the help of different field guides [10, 15, 17] and then released to protect the biodiversity loss. The unidentified butterflies were taken to the laboratory for further studies. The specimens were stretched, pinned and oven dried at 60°C for 72 hours and finally set into wooden boxes and labeled.

2.2.2 Species composition and characterization of status of butterflies

To determine the composition and distribution of identified butterflies, species were arranged according to their families and an inventory was prepared. The status of butterflies were characterized into three groups based on the number of sightings in the study area namely fairly common (FC= more than 30 sightings); common (C= 15-30 sightings); uncommon (UC= less than 15 sightings), respectively.

2.3 Analyzing diversity

(i). Shannon- Wiener diversity Index

The species diversity will be calculated based on Shannon Wiener Index(H) [27]:

$$H'(S) = - \sum_{i=1}^S p_i \log p_i$$

Where, pi = fraction of entire population made up of species i.
S = total number of species encountered
i = proportion of species

(ii). Evenness index

It was calculated as per Hill [12], i.e, $E = H / \ln S$

Where, S = total number of species, H = Index of species

(iii). Margalef's Index

This index was used as a simple measure of species richness Margalef [21],

Margalef's Index = $(S-1) / \ln N$

Where, S = total number of species

N = total number of individuals in sample

ln = natural logarithm

3. Results and Discussion

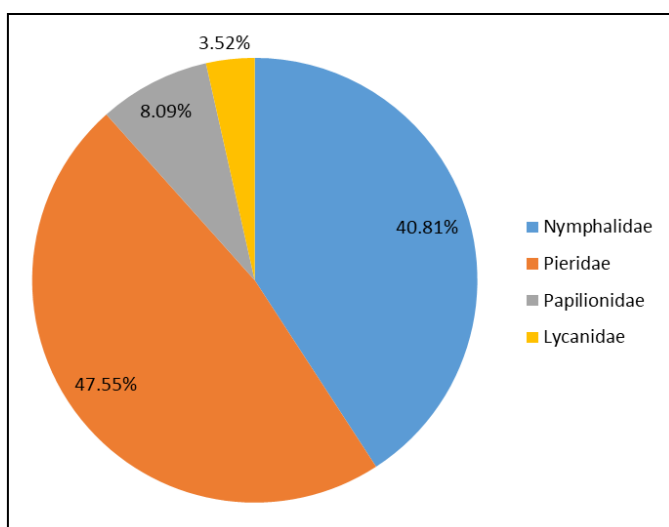
3.1 Species composition, distribution and status of butterflies:

The present study documented the total of 1247 individuals belonging to 33 species of butterflies, 27 genera and four families (Table 2). In terms of total number of species and genera, Nymphalidae was the most dominant family supported 17 species and 15 genera followed by Pieridae (9 species and 7 genera), Papilionidae (5 species and 3 genera) and Lycaenidae (2 species and 2 genera), respectively. Percent contribution of number of species of different families of butterflies recorded from the study area during the entire study period has been shown in Figure 1. Among the total number of species of butterflies recorded, *Catopsilia pomona* Fabricius was the most abundant species and constituted 13.71% of the total individuals followed by, *Eurema hecabe* Linnaeus (9.86%), *Pieris canidia* Sparrman (8.25%) and *Aglaia cashmerensis* Kollar (5.21%). On the other hand, *Graphium eurous* Leech was the least abundant species which constituted 0.32% of the total individuals followed by *Neptis zaida* Doubleday (0.56%) and *Papilio machaon* Linnaeus

(0.72%), respectively.

Table 2: Species composition, distribution and status of butterflies recorded in the study areas.

S. No.	Order: Lepidoptera	Common Name	Distribution			Status
Family: Nymphalidae Site 1			Site 2	Site 3		
1.	<i>Acraea issoria</i> (Hubner)	Yellow Coster	+	+	-	C
2.	<i>Aglaia cashmerensis</i> (kollar)	Indian Tortoiseshell	+	+	+	FC
3.	<i>Argyreus hyperbius</i> (Linnaeus)	Indian Fritillary	-	+	+	C
4.	<i>Ariadne merione</i> (Cramer)	Common castor	-	+	+	C
5.	<i>Aulocera swaha</i> (kollar)	Common satyr	-	+	+	FC
6.	<i>Callerebia annada</i> (Moore)	Ringed Argus	+	+	+	FC
7.	<i>Childrena childreni</i> (Gray)	Large Silverstripe	-	+	-	C
8.	<i>Cynthia cardui</i> (Linnaeus)	Painted Lady	-	+	+	C
9.	<i>Danaus genutia</i> (Cramer)	Common tiger	-	+	+	FC
10.	<i>Junonia atlites</i> (Linnaeus)	Gray pansy	+	+	-	C
11.	<i>Issoria lathonia</i> (Linnaeus)	Queen of Spain fritillary	+	-	+	C
12.	<i>Junonia iphita</i> (Cramer)	Chocolate pansy	+	+	+	FC
13.	<i>Junonia orithiya</i> (Linnaeus)	Blue pansy	-	+	+	FC
14.	<i>Kaniska canace</i> (Linnaeus)	Blue Admiral	+	-	+	C
15.	<i>Melanites leda</i> (Linnaeus)	Common evening brown	+	+	-	FC
16.	<i>Neptis zaida</i> (Doubleday)	Pale green sailer	+	-	-	UC
17.	<i>Venessa indica</i> (Herbst)	Indian red admiral	+	+	+	C
Family: Pieridae						
18.	<i>Aporia agathon</i> (Gray)	Great black vein	-	+	+	C
19.	<i>Catopsilia pomona</i> (Fabricius)	Common Emigrant	+	+	+	FC
20.	<i>Colias fieldi</i> (Menestries)	Dark clouded yellows	+	+	+	FC
21.	<i>Eurema brigitta</i> (Cramer)	Small grass yellow	+	+	-	C
22.	<i>Eurema hecabe</i> (Linnaeus)	Common grass yellow	+	+	+	FC
23.	<i>Gonopteryx rhamni</i> (Linnaeus)	Common brimstone	+	+	+	FC
24.	<i>Pareronia ceylanica</i> (Feldera)	Dark wanderer	-	+	+	C
25.	<i>Pieris brassicae</i> (Linnaeus)	Large cabbage white	+	+	+	FC
26.	<i>Pieris canidia</i> (Sparrman)	Indian cabbage white	+	+	+	FC
Family: Papilionidae						
27.	<i>Atrophaneura aidoneus</i> (Doubleday)	Lesser batwing	-	+	+	UC
28.	<i>Graphium eurous</i> (Leech)	Sixbar swordtail	-	+	-	UC
29.	<i>Graphium nomius</i> (Esper)	Spot swordtail	-	+	-	C
30.	<i>Papilio machaon</i> (Linnaeus)	Old world swallowtail	-	+	+	UC
31.	<i>Papilio polytes</i> (Linnaeus)	Common mormon	+	+	+	FC
Family: Lycaenidae						
32.	<i>Lycaena pavana</i> (Kollar)	White-bordered copper	-	+	+	C
33.	<i>Udara akasa</i> (Horsefield)	White hedge blue	+	+	+	C

**Fig 1:** Percent contribution of number of species of different families of butterflies recorded from the study area.

In comparisons in a more recent year, various workers have studied the butterflies diversity in different areas of the Nainital district. Some workers studied the diversity of butterflies of Jones Estate, a dying watershed in the Kumaon Himalaya, Uttarakhand [29]. Some workers have recorded the

total of 34 species belonged to nine families in the pine forest of Nainital, Kumaun Himalaya [9]. Few workers have observed 36 species of butterflies belonging to seven families in the landscape of Nandhour Wildlife Sanctuary, Nainital, Uttarakhand [2]. Similarly, many other workers have recorded 29 species belonged to six families from Pt. G.B. Pant High Altitude Zoo, Nainital [22]. Some workers have documented 35 species of butterflies from the moist deciduous teak forest patch in a Chorgalia range of Nandhour Wildlife Sanctuary, Nainital [26].

As per the status of butterflies recorded, 14 species of butterflies were characterized as fairly common (FC) and accounted 42.42% of the total species. Similarly, 15 species (45.45%) were characterized as common (C) and 4 species (12.12%) were uncommon (UC). Maximum number of "FC" species belonged to the family Nymphalidae (7 species) followed by Pieridae (6 species) and Papilionidae (1 species). Likewise, maximum number of "C" species belonged to the family Nymphalidae (9 species) followed by Pieridae (3 species), Lycaenidae (2 species) and Papilionidae (1 species) respectively. Maximum number of "UC" species belonged to the family Papilionidae (3 species) followed by Nymphalidae (1 species) as shown in Figure 2.

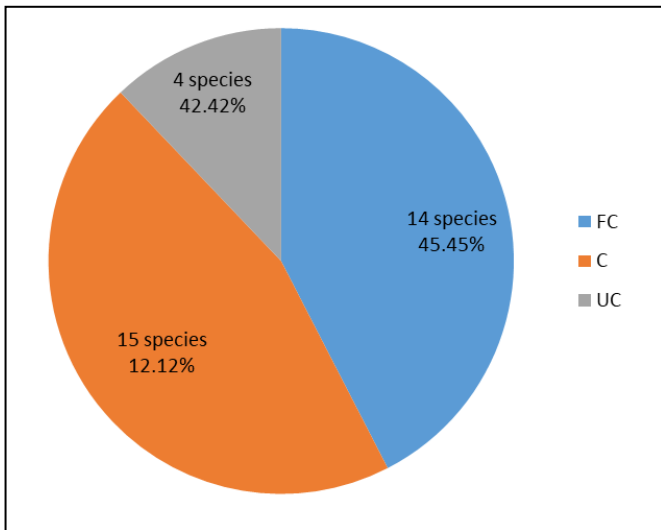


Fig 2: Status of different species of butterflies and their percent contribution recorded from the study sites.

3.2 Spatial distribution and seasonal parameters of butterflies

Analysis of various diversity indices of butterflies revealed that Shannon diversity index (H) was highest in site-2 (3.171) followed by site-3 (3.001) and site-1 (2.776). Evenness was highest in site-1 (0.84) followed by site-3 (0.80) and site-2 (0.79). Similarly species richness was highest in site-2 (4.547)

followed by site-3 (4.004) and site-1 (3.244) respectively. Margalef’s index was highest in site-2 (4.547) followed by site-3 (4.004) and site-1 (3.244) given in Table 3. Among the different selected study sites, site-2 (CITH) accounts 589 individuals and 30 species with maximum number, followed by site-3 (Khabrar) with 401 individuals and 25 species and site-1 (Satbunga – 257 individuals and 19 species) respectively (Figure 3). Seasonal variation in species richness and abundance of butterflies during the study period revealed that rainy season was noticed with the maximum number of species and individuals (640 individuals and 31 species) followed by summer (415 individuals and 26 species) and winter (192 individuals and 15 species) season, shown in Figure 4.

Table 3: Various diversity indices of butterflies in the study sites.

	Site-1 (Satbunga)	Site-2 (CITH)	Site-3 (Khabrar)
Taxa_S	19	30	25
Individuals	257	589	401
Dominance_D	0.07345	0.05265	0.06371
Simpson_1-D	0.9266	0.9473	0.9363
Shannon_H	2.776	3.171	3.001
Evenness_e^H/S	0.8453	0.7943	0.8042
Margalef	3.244	4.547	4.004

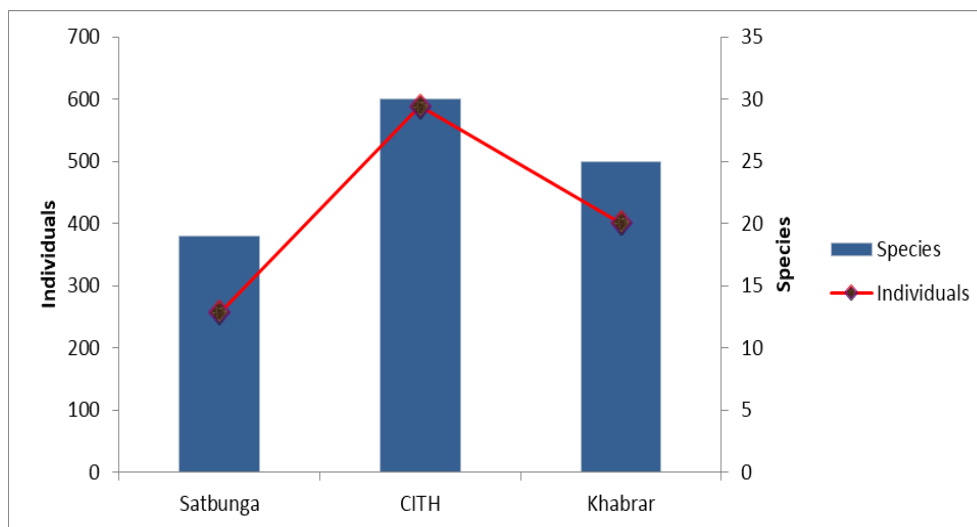


Fig 3: Species richness and abundance of butterflies of different study sites

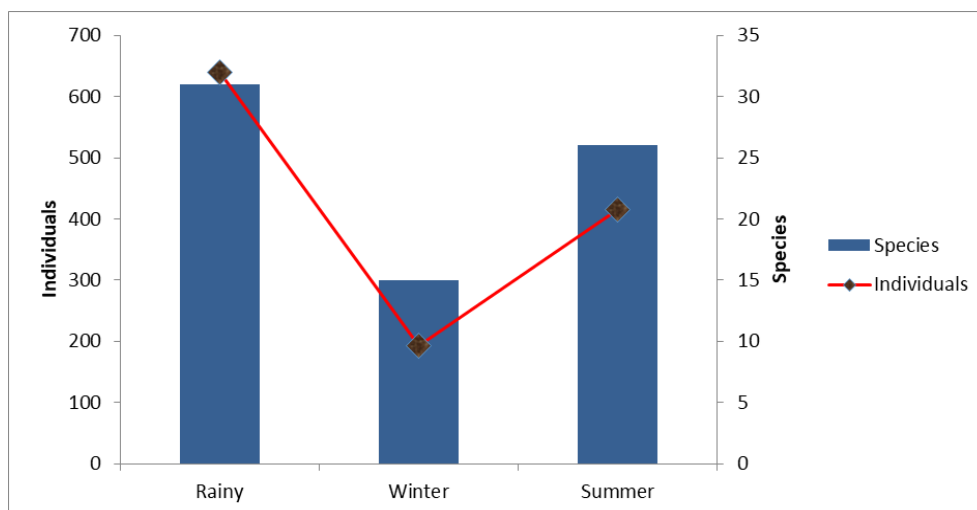


Fig 4: Seasonal variation in number of individuals and species of butterflies recorded from the study area.

In the present investigation, Nymphalidae was the most dominant family and a similar pattern was also reported by many authors in different parts of Indian Himalayan Region and Shivalik Foot Hills [13, 22, 31]. The seasonal distribution shows that Nymphalidae is the dominant family in all season with highest number of species and the species richness of Nymphalidae is due to their polyphagous nature, presence of food plants and is also related with their active flying habit

assist in searching varied food resources [19]. The frequency of occurrence of butterflies belonging to four families was estimated and the highest number of individuals of butterflies were observed in site-2 (589) followed by site-3 (401) and site-1 (257) respectively. It was reported during the present study that number of butterflies increased in the summer and post monsoon and decreased during winter. The results had been observed similar to the earlier findings [24, 30, 32].



Plate 1: Photographs of butterflies of different families recorded from the selected orchards of temperate fruit trees.

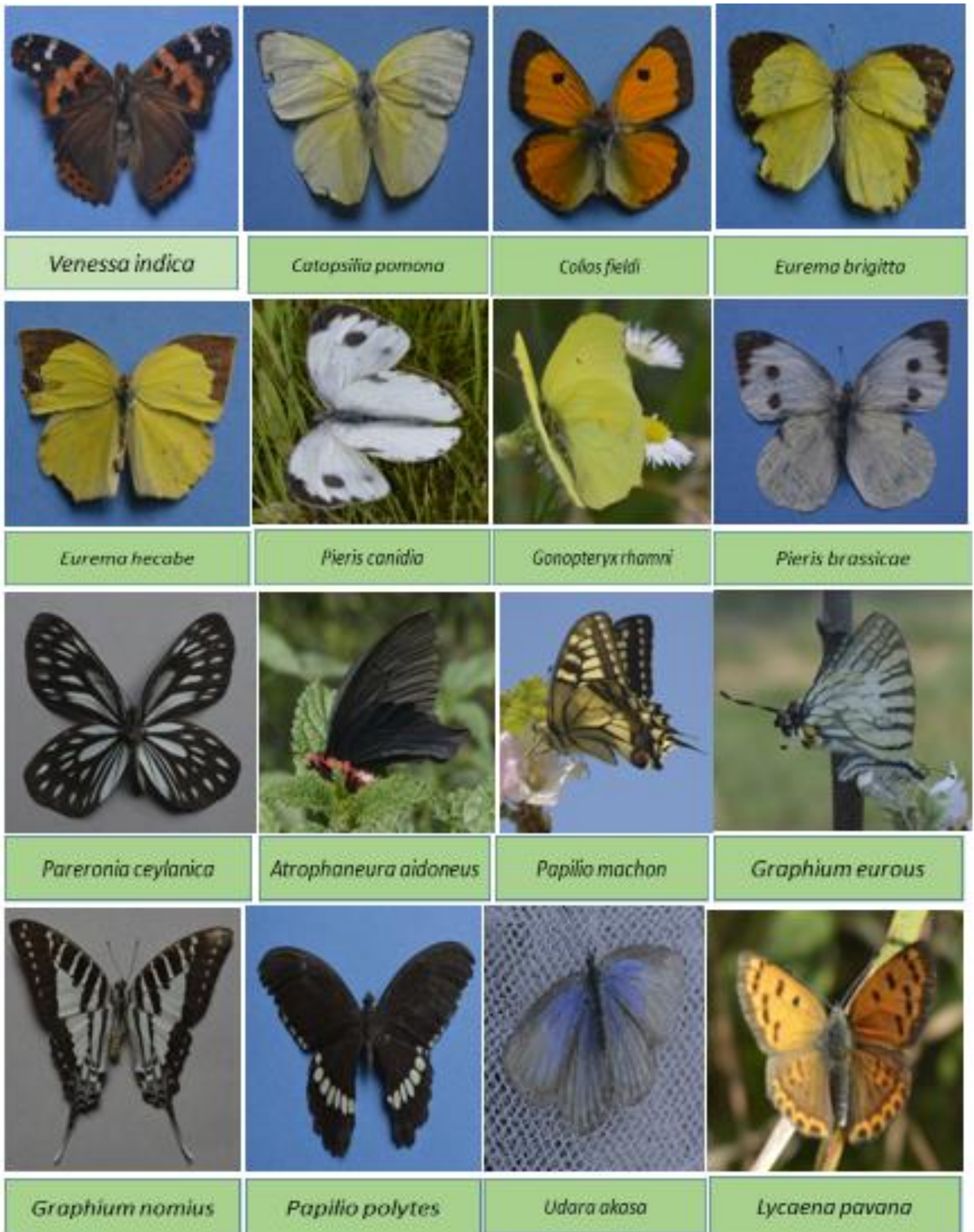


Plate 2: Photographs of butterflies of different families recorded from the selected orchards of temperate fruit trees.

4. Conclusion

Observations made in the present study conclude that Nymphalidae was the most dominant family in terms of number of species followed by Pieridae, Papilionidae and Lycaenidae. The study area supports rich diversity of butterflies accounting wide varieties of fruit trees which

provide them an ideal breeding habitat and nectar as well. Maximum number of species and individuals of butterflies were recorded in the rainy season because rainfall conditions greatly influence the butterfly numbers and species distribution. If the diversity of the fruit tree varieties could be increased, the diversity of butterflies may also be influenced

as it had been observed in the present investigation that fruit orchards having maximum fruit tree varieties support maximum butterfly diversity. The present study of butterflies is not conclusive, a future explanation will be needed to update this checklist. Thus it is suggested that the area under study and other such areas should be continuously surveyed and monitored to add new taxa to the existing biodiversity.

5. Acknowledgement

The authors are immensely grateful to Head, Department of Zoology, D.S.B. Campus, Kumaun University, Nainital for providing the necessary research facilities. We are highly thankful to the Director, Central Institute of Temperate Horticulture, Mukteshwar, Nainital for the permission and the owner of the fruit orchards for allowing us to do the field work in the selected sites. The authors extend their thanks to the local people for their cooperation and help throughout the field study.

6. References

1. Antony AK, Prasad G, Kalesh S. Diversity and abundance of butterflies of Kerala University Campus, Kariavattom Thiruvananthapuram. *Journal of Entomology and Zoology Studies*. 2016; 4(5):1074-1081.
2. Arya MK, Dayakrishna, Chaudhary R. Species richness and diversity of butterflies in and around Kumaun University, Nainital, Uttarakhand, India. *Journal of Entomology and Zoology Studies*. 2014; 2(3):153-159.
3. Arya MK, Dayakrishna. Species richness and diversity of butterflies in the landscape of Nandhour Wildlife Sanctuary, Nainital, Uttarakhand. *Journal of Environment and Bio-Sciences*. 2017; 31(2):307-315.
4. Balakrishnan VC, Palot MJ. A checklist of larval food plants of butterflies in Kerala. *Proceedings of National seminar-cum- Workshop on butterfly diversity of Western Ghats, Malappuram, Kerala*. 2004, 34-35
5. Barlow J, Overal WL, Araujo IS, Gardner TA, Carlos AP. The value of primary, secondary and plantation forests for fruit-feeding butterflies in the Brazilian Amazon. *Journal of Applied Ecology*. 2007; 44:1001-1012.
6. Das J, Parida SP. Preliminary study of butterflies species variation in FRI campus in accordance in accordance to its micro climatic condition. *Current Life Sciences*. 2015; 1(3):112-117.
7. Fleishman E, Murphy DD, Brussard PF. A method for selection of umbrella species for conservation planning. *Ecological Applications*. 2000; 10:569-579.
8. Gadagkar R, Chandrashekhara K, Nair P. Insect species diversity in tropics: sampling method and case study. *Journal of the Bombay Natural History Society*. 1990; 87(3):328-353.
9. Garia A, Goswami D, Kaushal BR. Diversity and abundance of Lepidoptera in a pine forest of Kumaun Himalaya. *Journal of Environment and Bio-Sciences*. 2016; 30(2):477-480.
10. Haribal M. *The Butterflies of Sikkim Himalayas and their Natural History*. Natraj Publishers Dehradun. 2003, 1-217.
11. Harisha MN, Hosetti BB. Butterfly fauna of Daroji Sloth Bear Sanctuary, Hospet, Bellary District, Karnataka India. *Journal of Research in Biology*. 2013; 3(2):840-846.
12. Hill MO. Diversity and its evenness, a unifying notation and its consequences. *Ecology*. 1973; 54:427-432.
13. Joshi PC, Arya M. Butterfly Communities Along Altitudinal Gradients in a Protected Forest in the Western Himalayas, India. *The Natural History Journal of Chulalongkorn University*. 2007; 7(1):1-9.
14. Kapkoti B, Joshi RK, Rawal RS. Variations in the abundance and diversity of insects in apple orchards of Kumaun, Western Himalaya, India. *Current Science*. 2016; 110(3):438-443.
15. Kehimkar I. *The book of Indian butterflies*. Bombay natural History Society- Oxford University Press. 2014, 1-497.
16. Kocher SD, Williams EH. The diversity and abundance of North American butterflies vary with habitat disturbance and geography. *Journal of Biogeography*. 2000; 27:785-794.
17. Kumar P. *Handbook on Common Butterflies of Uttarakhand. Zoological survey of India, Kolkata*, 2008. 1-136.
18. Kumar A. Butterfly abundance and species diversity in some urban habitats. *International Journal of Advanced Research*. 2014; 2(6):367-374.
19. Kunte K, Joglekar A, Utkarsh G, Padmanabhan P. Patterns of butterfly, bird and tree diversity in the Western Ghats. *Current Science*. 1999; 77(4):577-586.
20. Kunte K. Seasonal patterns in butterfly abundance and species diversity in four tropical habitats in the Northern Western Ghats. *Journal of Bioscience*. 1997; 22:593-603.
21. Margalef's R. Temporal succession and spatial heterogeneity in phytoplankton. In: *Perspectives in Marine biology*, Buzzati-Traverso (ed.), Univ. Calif. Press, Berkeley. 1970; 323-347.
22. Meena DS, Dayakrishna. Study on the species composition and status of free ranging butterflies (Lepidoptera: Rhopalocera) in Pt. G.B. Pant High Altitude Zoo, Nainital, Uttarakhand. *Journal of Entomology and Zoology Studies*. 2017; 5(4):1135-1139.
23. Padhye AD, Dahanukar N, Paingankar M, Deshpande M, Deshpande D. Seasonal and Landscape wise distribution of butterflies in Tamhini, Northern, Western Ghats, India. *Zoos' Print Journal*. 2006; 21(3):2175-2181.
24. Panicker VP, Anuraj R, Shankar G, Aswathy S, Gopalakrishnan A, Biju S. Studies on the diversity of butterfly (Lepidoptera: Rhopalocera) fauna in college of veterinary and animal sciences campus, Mannuthy, Thrissur, Kerala, India. *Journal of Entomology and Zoology Studies*. 2016; 4(5):933-936.
25. Parmesan C. Butterflies as bioindicators for climate change effects. In: C.L. Boggs, W.B. Watt & P.R. Ehrlich (eds.) *Evolution and Ecology Taking Flight: Butterflies as Model Systems*. University of Chicago Press, Chicago. 2003, 541-560.
26. Sanwal CS, Dhakate PM, Joshi KP, Neethu Lakshmi M. Habitat conservation through butterfly zone: A new approach to *in-situ* conservation of butterfly diversity. *Journal of Entomology and Zoology Studies*. 2017; 5(6):2195-2199.
27. Shannon CE, Wiener W. *The mathematical theory of communication*. Univ. of Illinois Press, Urbana, U.S.A, 1949.
28. Shobana G, Gunasekaran C, Lena M, Agnes DA, Sharmila BA. Diversity and abundance of butterflies in Villupuram District, Tamil Nadu, South India. *International Journal of Recent Scientific Research*. 2012; 3(7):637-639.
29. Smetacek P. *Butterflies (Lepidoptera: Papilionidea and*

- Hesperideae) and other protected fauna of Jones Estate, a dying watershed in the Kumaon Himalaya, Uttarakhand, India. *Journal of Threatened Taxa*. 2012; 4(9):2857-2874.
30. Sreekumar PG, Balakrishnan M. Habitat and altitude preferences of butterflies in Aralam Wildlife Sanctuary, Kerala. *International Society of Tropical Ecology*. 2001; 42(2):277-281.
 31. Tewari R, Rawat GS. Butterfly Fauna of Jhilmil Jheel Conservation Reserve, Haridwar, Uttarakhand, India. *Biological Forum- An International Journal*. 2013; 5(2):22-26.
 32. Thomas JA. Monitoring change in the abundance and distribution of insects using butterflies and other indicator groups. *Philosophical Transactions of the Royal Society B*. 2005; 360:339-357.
 33. Tiple AD, Deshmukh VP, Dennis RLH. Factors influencing nectar plant resources visits by butterflies on a university campus: implications for conservations for conservation. *Nota Lepidopterologica*. 2006; 28:213-224.
 34. Tiple AD. Butterflies of Vidarbha region Maharashtra, India; A review with and implication for conservation. *Journal of Threatened Taxa*. 2011; 3(1):1469-1477.
 35. Tiple AD. Butterfly species diversity, relative abundance and status in Tropical Forest Research Institute, Jabalpur, Madhya Pradesh, Central India. *Journal of Threatened Taxa*. 2012; 4(7):2713-2717.
 36. Tyagi R, Joshi PC, Joshi NC. Butterfly diversity of district Nainital, Uttarakhand (India). *Journal of Environment and Bio-Sciences*. 2011; 25(2):273-278.
 37. Venkata Ramana SP. Biodiversity and conservation of butterflies in the Eastern Ghats. *The Ecoscan*. 2010; 4(1):59-67.
 38. Williams PH, Gaston KJ. Biodiversity indicators: Graphical techniques, smoothing and searching for what makes relationships work. *Ecorgraphy*. 1998; 21(5):551-560.