International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 20-03-2024, Accepted: 10-04-2024, Published: 04-05-2024
Volume 9, Issue 5, 2024, Page No. 4-9

Entomofauna diversity in Kartik Swami, Rudraprayag, Uttarakhand

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Abstract
Insects are one of the most diverse successful and dominant taxon groups on the earth. Insects are found in almost all the world's habitats. They play a major role in ecosystem function. The main aim of this study is to collect and identify insect diversity and abundance in Kartik swami Rudraprayag Uttarakhand. A great variety of vegetation occurs in the study area this region consists of mixed broad-leaved forests with banj oak, moru oak, kharsu oak, etc. During this study, numerous species of insects were collected and identified for assessment of the insect diversity in Kartik swami. Four sites were chosen for study kankchauri, jogimaridi, usuntoli, kartik swami. In this study, a total of 508 individuals belonging to 59 species of 34 families and 6 orders were recorded during the study period. There Were Lepidoptera was the most dominant order which constituted 167 number of individuals recorded followed by Diptera 160, Hymenoptera 63 Hemiptera 59, Coleoptera 38, and Orthoptera 21. Overall, relatively high biodiversity in the present area.

Keywords: Biodiversity, Insects, Orders

Introduction
Biodiversity is both a measure of life and an indicator of the overall health of our planet. Biological diversity refers to the entire body of organisms, their ecological complexity within the environment, and all the ecological processes with their systems (Primack, 1993) [1] Biological diversity can constantly provide an essential ecological service through enhancing the resilience of the ecosystem. (Elmqvist et. al., 2003) [2].

Insects
insects are one of the most diverse successful and dominant taxon groups on the earth. Insects play an essential role in our environment Insects have important economic roles supporting and providing livelihood for numerous people from the silk trade to beekeeping and the pollination of most of our fruit and a range of agricultural produce. Insects also help to improve the physical condition of the soil and promote fertility by burrowing and devouring bodies of dead animals and plants and also as bioindicators. A great variety of vegetation occurs in the study area this region consists of mixed broad-leaved forests with banj oak, moru oak, karsu oak, etc. The main aim of this study is to identify insect diversity and abundance in Kartik Swami Rudraprayag, Uttarakhand.

Materials and methods
Study area: The present study was conducted from August 2023 to January 2024 in the Kartik swami area of district Rudraprayag, India. The entire area represents a characteristic high altitudinal range of 2400-3050m. The temperature was recorded during the study period The highest temperature was 29°C and the Lowest was -5°C. The study site is surrounded by mixed oaked forests. For the present study, 4 study sites were used for data collection which are as follows;

Site 1 (Kanakchauri): This site is about 4.2 Km away from the Kartik swami temple and about 40 Km from Rudraprayag. Kanakchauri lies between latitude 30°38’64” N., and longitude 79°11,88” E. It is situated at an altitude of 2800m.

Site 2 (Jogi Maridi or Dharamshala Kartikswami): This site is about 3 Km from the Kankchauri and 1 km from Kartik Swami temple. Andis is situated altitude of 30°21’38” N and a longitude of 79°10’85” E altitude of 2,900 m.

Site 3 (Usuntoli): It is situated at N 30°25’61 and E′ 79°9’80 and is at an altitude of 2850 m.

Site 4 (Kartik swami): This site is about 44 Km from Rudraprayag. ′ longitude 30°23’78” N It is situated at latitude 79°5’54: E and is at the highest altitude which is 3048 m

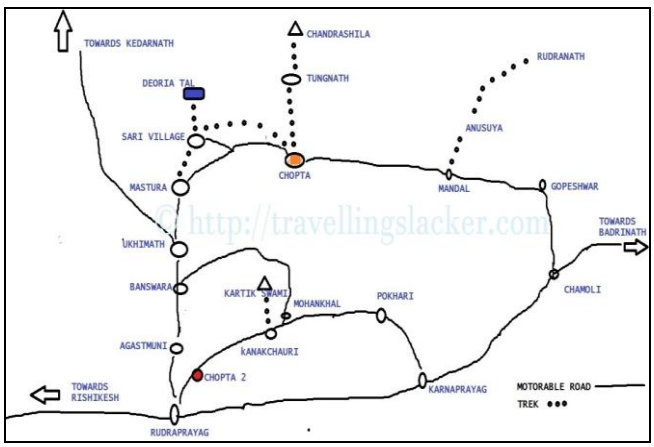


Fig 1: Kartik swami trek

Vegetation: A great variety of vegetation types occur in the Kartik swami region This region consists of mixed 'broad-leaved forest with Banj oak (Quercus leucotricophora) and MoruOak (Q. dilatata), Kharsuoak (Q. semecarpifolia). Anaphilismargaritacea, Saxifraga granulata (Fig.2)

Fig 2: Mixed Oak Forest

Collection and Identification of insects

The direct observation method was used twice a week for the sampling of insect species. Insect species were observed from 10.00 am to 3.00 pm in the daytime During the study period. Insects were identified by using available literature and order-wise field guides along with their respective characters. Different volumes of 'Fauna of British India' books were also used to study the characteristics of insects for identification. Sometimes unidentified specimens were examined by comparing them with the already identified specimens with the help of other taxonomists/researchers. Online resources like 'Butterfly of India', 'Moths of India', 'Odonata of India', 'Beetles of India', iNaturalist.org, etc. were also used for the identification of some insects and to get an expert review.

Statical Analysis

The diversity of insect species was calculated using the Shannon-Wiener diversity index (H) (Shannon Wiener, 1949) $H = -\sum pi \times \ln(pi)$. Where $pi = ni/N$, ni is the number of individuals of the species and $N = \sum ni$. ln = the natural log $\sum$ = the sum of calculations to find the evenness of species Pielou's species evenness index
(J) was used (Pielou, 1966). Relative abundance was used to show the family-wise and order-wise composition of insects.
Relative abundance (%) = (n/N) × 100 Where n Number of each individual (N)= Total number of individuals.

Result and Discussion

Table 1 shows the diversity abundance of insect species discovered in the study area. A total of 508 individuals belonging to 59 species of 34 families and 6 orders were recorded from four different study sites during the study period 14 species common to all study sites. Among the total insects recorded Lepidoptera was found to be the most dominant order with 19 species Constituting about 32.20% of total abundance (fig.3) followed by Diptera (15 Species, 25.42%), Coleoptera (10 species 16,9%), Hemiptera (7 species 11.86%), Hymenoptera (6 species 10.16%), and Orthoptera (2 species 3.39%). (able-2)

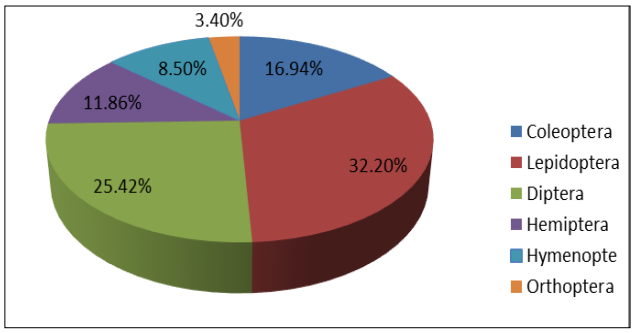


Fig 3: Relative abundance of species (%) of different orders

Table 1: Species richness and relative abundance (%) of insect fauna collected from the study area.

	Taxonomic composition	Common name	Site1	Site2	Site3	Site 4	Relative abundance
	Order- Coleoptera (7 Family,10 Species)						
	Family Lycidae						
1	*Lygistopterussanguineus*	Lygistopterus	+	+	+	+	1.40
	Family: Meloidae						
2	*Hycleusaffinis*	Blister beetle	+	+	+	-	0.98
	Family: Chrysomelidae						
3	*Paria thoracica*	Leaf beetle	-	-	+	-	0.60
4	*Criocerisduodecimpunctata*	Spotted asparagus beetle	-	+	-	+	0.78
5	*Chrysolinacoerulans*	Blue mint beetle	-	-	+	+	1.18
6	*Chrysolinafastuosa*	Broad-bodied beetle	+	-	-	+	0.68
	Family: Anthicidae						
7	*Anthicidaespe.*	Antlike beetles	+	+	-	-	0.78
	Family: Carabidae						
8	*Abax parallelepipedus*	Abax	+	-	+	-	0.60
	Family Attelabidae						
9	*Attelabidaespe.*	Attelabidae	-	-	+	-	0.39
	Family: Curculionidae						
10	*Curculio nucum*	Nut weevil	-	-	+	-	0.60
	Order Lepidoptera (6 Family,19 species)						
	Family: Nymphalidae						
11	*Ariadne merione*	Common cator	+	+	+	+	1.77
12	*Hipparchia fagi*	Woodland grayling	+	+	+	+	3.15
13	*Symbrenthialilaea*	Jester	+	+	+	+	2.55
14	*Junoniahierta*	Yellow pansy	-	+	-	-	1.57

15	*Vanessa cardui*	Painted lady	+	+	+	+	2.95
16	*Vanessa indica*	Indian red adrimal	+	+	-	+	2.55
17	*Aglaiscaschmirensis*	Himalyantortoishell	+	+	+	+	4.92
18	*Auloceraswaha*	Aulocera	+	+	-	-	1.18
	Family: Erebidae						
19	*Syntomoidesimaon*	Handmaiden moth	-	-	+	-	1.57
	Family: Zygaenidae						
20	*Campyloteshistrionicus*	Drurys jewel	-	+	-	-	0.68
	Family: Papilionide						
21	*Papilio polytes*	Common Mormon	+	-	-	-	0.78
	Family: Pieridae						
22	*Colias electro*	Clouded yellow	-	-	+	-	0.98
	Family: Lycanidae						
23	*Heliophorusepicles*	Purple sapphire	+	+	+	+	3.34
24	*Jamides celeno*	Common cerulean	+	+	+	-	2.16
25	*Chrysozephyrus*	Chrysozephyrus	+	+	-	-	0.78
26	*Neozephyrusquercus*	Neozephyru	-	-	+	-	0.60
27	*Celastrinaargiolus*	Celastrina	-	-	-	+	0.39
28	*Thoressa cerata*	Thoressa cerata	+	-	-	-	0.39
29	*Dodona durga*	Dodona	+	-	+	-	0.60
	Order- Diptera (8 Family,15 Species)						
	Family: Muscidae						
30	*Thricops sp.*	Red fly	+	+	+	+	2.16
31	*Phaonia pallid*	Orange muscid fly	+	+	-	+	1.77
32	*Phaoniaarticeps*	Phaonia	-	+	+	-	1.37
33	*Pollenia pediculata*	Fly	+	+	+	+	2.75
	Family: Tipulidae						
34	*Tipulalongiventris*	Europian crane fly	+	+	+	+	2.75
35	*Tipula luna*	True cranefly	+	+	-	+	1.96
	Family: Bibionidae						
36	*Plecianearctica*	Lovebug	+	+	-	+	2.75
	Family: Tachinidae						
37	*Carcelia sp.*	Carcelia	+	-	+	-	1.77
38	*Exoristalarvarum*	Fly	-	-	+	-	1.57
	Family: Syrphidae						
39	*Eristalinustaeniops*	Hoverfly	+	+	+	+	3.54
40	*Platycheirusclypeatus*	Sedgesitters	-	+	-	+	1.57
	Family: Calliphoridae						
41	*Calliphora vomitoria*	Blue bottle fly	-	-	+	+	1.77
	Family: Asillidae						
42	*Stichopogoncatulus*	Stichopogon	+	-	+	-	1.77
	Family: Tabanidae						
43	*Tabanussulcifrons*	Tabanus	-	+	-	+	1.18
44	*Melanostomamellinum*	Melanostoma	-	+	+	+	1.37
	Order-Hemiptera (6 Family, 7 Species)						
	Family Pentatumidae						
45	*Oebaluspungnax*	Rice sting bug	+	+	+	+	3.15
	Family: Miridae						
46	*Placochilusseladonicus*	Box bug	-	-	+	-	1.77
	Family Pyrrhocoridae						
47	*Pyrrhocorisapterus*	Firebug	-	+	-	+	1.18
	Family Pentatomoidea						
48	*Acanthosomalabiduroides*	Pentatomoidea	+	+	+	+	1.96
	Family Cicadellidae						
49	*Aguriahanastelluata*	Aguriahana	-	-	+	-	1.37
50	*Atkinsoniellaheiyuana.*	Leafhopper	-	-	+	-	0.98
	Family; Corixidae						
51	*Hesperocorixacastanea*	Water boatman	-	-	+	-	1.18
	Order-Hymenoptera (4 Family,6 Species)						
	Family- Ichneumonidae						
52	Ichneumon wasp sp.	Ichneumon wasp	+	+	+	+	2.36
53	*Diphyusprovancheri*	Diphyus	+	+	+	-	1.96
54	*Cratichneumoncoruscator*	Cratichneumon	-	-	+	-	1.57
	Family Sphecidae						
55	*Ammophilapubescens*	Sand wasp	+	-	+	-	1.77
	Family Vespidae						
56	*Polistes Canadensis*	Red paper wasp	+	+	+	+	2.75
	Family Halictidae						

57	*Sphecodes gibbus*	Blood seew	+	+	+	+	2.16
	Order- Orthoptera (2Family, 2 Species)						
	Family Gryllidae						
58	*Velarifictorusmicado*	Japanese burrowing	-	-	+	-	0.98
	Family Acrididae						
59	*Euthystirabrachyptera*	Gomphocerus	+	+	+	+	3.15

In terms of the number of individuals, the maximum number of individuals belonged to the order Lepidoptera (167) number of individuals recorded followed by Diptera (160), Hymenoptera (63), Hemiptera (59), Coleoptera (38), Orthoptera (21) respectively (Table 2). Overall, relatively high biodiversity in the present area. In 34 families Nymphalidae was the most dominant family constituting about 13.55% of total abundance followed by Lycanidae 11.8%, Muscidae 6.74%. Based on the observations, *Aglaiscaschmirensis* was the most abundant and frequently sighted species in all those study sites constituting 4.92% of the total individuals of insects recorded in the present study. The other frequently observed insects in the study sites include insects such as *Eristalinustaeniops, Hipparchia fagi, Euthystirabrachptera, Oebaluspungnax*, etc. Four sites were chosen to study the number of species obtained from per site respectively, Site 3 Usun toil supported the maximum number of insect species (42 species), followed by 1 Kanakchaunri- (35 species), Site 2Jogi Maridi – (35species), and Site 4 Kartik swami – (30species). (Table 2).

Table 2: Number of individual and relative abundance of different orders of insects recorded from study sites.

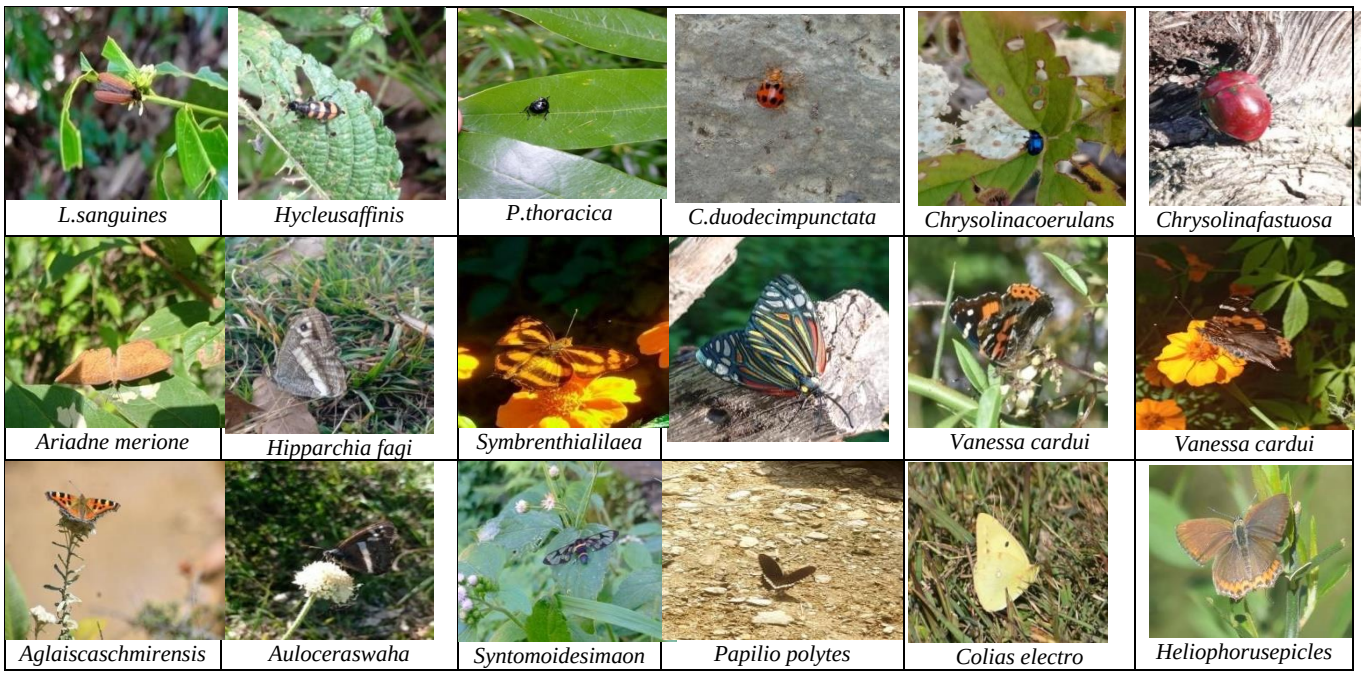
S.NO	ORDER	NO. of Individual	Relative abundance
1	Coleoptera	38	7.48
2	Lepidoptera	167	32.87
3	Diptera	160	31.49
4	Hymenoptera	63	12.40
5	Hemipetera	59	11.61
6	Orthoptera	21	4.13
		508	**100**

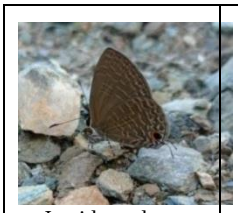
Table 3: Diversity indices of insects in Kartik swami Uttarakhand

Months	Species no	Abundance (N)	Relative abundance	Shannon wiener index	Evenness
August	11	82	16.14	2.32	0.967
September	18	126	24.80	2.79	0.965
October	15	136	26.77	2.65	0.978
November	9	91	17.91	2.17	0.987
December	4	60	11.81	1.38	0.995
January	2	13	2.55	0.54	0.779

Conclusion

A total of 508 individuals belonging to 59 species of 34 families and 6 orders were recorded during the study period. In conclusion, the present survey has shown that the Kartik Swami region is rich in insect biodiversity. It has also been documented probably for the very first time.




Jamides celeno


Chrysozephyrusquercus


Neozephyrusquercus


Celastrinaargiolus


Thoressa cerata


Dodona durga


Thricops


Phaonia pallid


Phaoniaarticeps


polleniapediculata

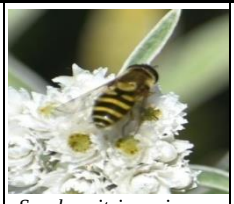

Tipulalongiventris


Tipula luna


Plecianearctica


Carcelia


Exoristalarvarum


Syrphusvitripennis


Platycheirusclypeatus


Clliphora vomitoria


Stichopogoncatulus


Tabanussulcifrons


Melanostomamellinum


Oebaluspungnax


Placochilusseladonicus


Pyrrhocorisapterus


Acanthosomalabiduroides


Aguriahanastelluata


Atkinsoniellaheiyuana


Hesperocorixacastanea


Ichneumon sp.


Diphyusprovancheri


Cratichneumoncorusc ator


Ammophilapubescens


Polistes Canadensis


Sphecodes gibbus


Euthystirabrachyptera


Velarifictorusmicado

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