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Dynamics in Diversity of Insects Fauna in Cropland of Ramnagar (Corbett City), Uttarakhand, India

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ABSTRACT
Insect biodiversity is the measure of ecosystem health and is foundation of ecosystem services to human well being. Insect biodiversity is the variability among living organism from all sources, including terrestrial, marine and other aquatic ecosystems. The present study area Ramnagar (Corbett City) is a small and beautiful tourist hill station in Northern India and has a large biodiversity of insects due to the large crop lands, orchards and forests. Anthropogenic activities have increased in few years and in recent past human population from nearby areas of Uttarakhand is migrating to Corbett City. Due to increased human interference, insect biodiversity of Corbett City is declining. A decrease of insects can be seen because of habitat loss, over-exploitation, pollution, overpopulation and global climatic changes. Conservation of insects is important to reduce the declining population of insect biodiversity. The aim of study is to analyze the insect biodiversity, species richness and abundance.
Keywords: *Anthropogenic activity, Insect biodiversity, Cropland*

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INTRODUCTION

Insects comprise more than 75 % of all described animal species and about 7,51,000 known species of insects which is about three-fourths of all species of animals on the planet [9]. Approximately 30 million species are found worldwide, of which about 1.4 million have been briefly described [7]. The most successful insect order, Coleoptera, represents about 38% (3,87,100 species) of the insect species of the world [29]. They have adopted for almost every feasible type of environment from the equator to the arctic and from sea level to the snowfield of highest mountains, land and air [8]. Earlier conducted studies demonstrated that not only the number of pollinators influences the pollination service but also the pollinator diversity has a significant effect in increasing the chance of pollination [25]. Insects perform many important ecological functions [23]. Insect pollinators and flowering plants have mutual relationships. Nectar and pollen are food rewards for insect pollinators [3]. Interaction between plant and pollinator can help pollination, especially in plants that are self-incompatible [4]. Insects are the main components of biodiversity and are indicators of environmental degradation [24]. In general, organic farming is reported to increase arthropod diversity in agricultural landscapes [6, 15, 21].

An agro-ecosystem which includes crop habitats and non-crop habitat [28, 22]. Most agro-ecosystems tend to be highly disturbed and common practices like tillage, planting, application of fertilizers and pesticides, irrigation and harvest can cause changes in average environmental conditions that change the functioning of the ecosystem [5]. However, the major factor responsible for the loss of insect populations during the last few decades is the widespread use of organic pesticides [30]. Ecosystems depend heavily on insect activity and insects play crucial roles in ecosystem function, nutrient recycling, pollinate plants, disperse seeds, maintain soil structure and fertility, control populations of other organisms, provide a major food source for other organisms [19]. The bee pollination in the study area is under threat because people in certain parts of Northeast India not only consume the honey and larvae of this insect, but also fry and eat the adult honey bees [2].

Hymenopterans are largest and diversified assemblages of beneficial insects constitute the most important group of pollinating insect [20]. The present investigation evaluated the fluctuating diversity of insects of Sawal Deh area of Ramnagar and to analyze the relative impact of human activities. This study will help in learning a great deal about the behavior and relationships between insects and plants in the fields and will help in the management of ecosystems.

MATERIAL AND METHODS

Study Area: Ramnagar is located at 29.40^0 N 79.12^0 E. It has an average elevation of 345m (1,132 feet) and the state of Uttarakhand is situated between $28^0\ 53^0\ 24^0$-$31^0\ 27^0\ 50^0$ N and $77^0\ 34^0\ 27^0$-$81^0\ 02^0\ 22^0$ E. It is located approximately 65 km from Nainital, Uttarakhand. Ramnagar is located at the foothills of the Himalayas on the bank of river Kosi. Ramnagar being located in the center was selected to represent agro-ecosystem in mixed crop zone. A survey was made to select the crop fields of sugarcane, wheat, soybean, maize, paddy and mustard in Ramnagar, Uttarakhand (fig. 1 and fig. 2).

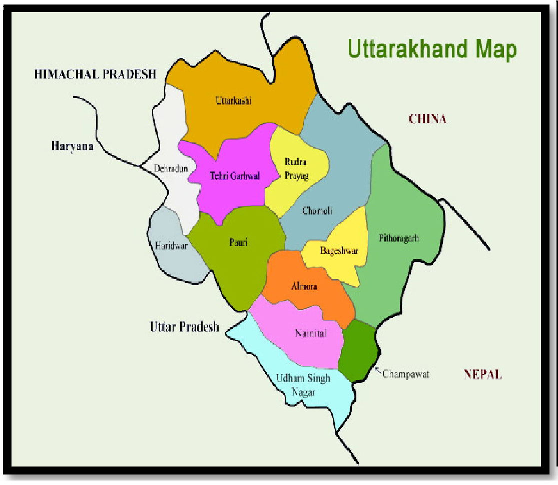


Fig.1. Map of Uttarakhand

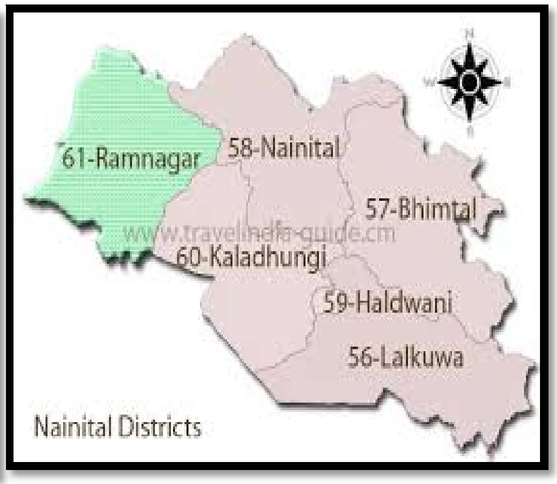


Fig.2. Map of study site

Sampling Site: The study site was Sawal Deh village which is located in Ramnagar Tehsil of Nainital district in Uttarakhand, India. It is situated 7 Km away from sub-district headquarter Ramnagar and 75 Km away from district headquarter Nainital. Paddy, wheat, mustard, soybean and maize are agriculture commodities grown in this village.

Sampling of Insects: Study was conducted from April 2017 to March 2019, in the selected field. The samples were collected from soil, ground surface, plants surface and air. Sweep net was used to sweep all types of insect fauna. The insects were collected by sweep sampling method [13]. Collection is done in each month by using standard protocols. For the collection of insects sweep sampling method, Hand picking, Shaking or beating and equipments were used. Hair brush, Forceps, Stick and Killing bottle were used collection and preservation of insects. The dead insects were transferred into boxes for temporary storage. The sacrificed insects were then properly pinned by steel pins and kept for proper drying. Naphthalene balls were placed inside the insect boxes to prevent from fungus. After the identification, the insects were labeled properly.

Data Analysis:

I. Shannon-Wiener diversity Index

The species diversity was calculated using Shannon Wiener Index (H)

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

Where, pi = fraction of total 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, i.e,

$$E = H/ \ln S$$

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

III. Margalef's Index

Species richness was calculated using Margalef's Index

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

Where, S = total number of species

N = total number of individuals in sample
In = natural logarithm

RESULTS AND DISCUSSION

A total 1,140 insects sample has been collected during months from April 2017 to March 2019. Overall, 4 orders, 11 families, 1,140 individuals of insects belonging to 37 species have been recorded during the study period in Table 1**.** According to the total number of species, dominant order is Lepidoptera (29 species) followed by Odonata (4 species), Coleoptera (2 species) and Hymenoptera (2 species) in fig. 3. Among order Lepidoptera, the family Pieridae and Nymphalidae were the most dominanted with 9 species each respectively, followed by Papilionidae (5 species), Danaidae and Lycaenidae each shared 3 species. Among order Coleoptera, the family Scarabaeidae and Coccinellidae each shared 1 species. Among order Hymenoptera, the family Apidae (2 species). Among order Odonata, the family Libellulidae (2 species), Calopterygidae and Chlorocyphidae each shared 1 species. Diversity indices, richness and evenness for three seasons were calculated in Table 3. Percent contribution of the relative number of individuals and species of different families of insects collected from study area are presented in Table 2. Among order Lepidoptera, the family Pieridae and Nymphalidae were the most dominant families which constituted 24.3% of the total collected insects. Family Pieridae, *Eurema brigtta* Cramer was the most dominant species of this family which constituted 26.18% of total individuals of this family followed by *Pieris brassicae nepalensis* Doubleday (22.18%), *Catopsilia pomana* Fabricius (18.18%), *Catopsilia pyranthe* Linnaeus (17.45%), *Pieris canidia canidia* Evans (10.18%), *Colias electo fieldi* Menestries (2.18%), *Pareronia valeria* Cramer (1.45%), *Cepora nerissa* Fabricius (1.45%) and *Pontia daplidice* Linnaeus (0.727%). Family Nymphalidae was the second most dominant family which constituted 24.3% of the total collected butterflies. *Precis lemonias* Linnaeus was the most dominant species of this family which constituted 60.29% of total individuals of this family, followed by *Cynthia cardui* Linnaeus (11.76%), *Precis almanac* Linnaeus (10.29%), *Venessa cashmirensis* Kollar (5.88%), *Phalanta phalanta* Drury (3.67%), *Precis iphita iphita* Cramer (2.94%), *Parathyma opalina* Kollar (2.94%), *Precis orythia* Linnaeus (1.47%) and *Sephisa dichora* (0.73%). Family Papilionidae was third most abundant family which constituted 13.6% of the total recorded individuals of insects and represented by 5 species. *Papilio protenor romulus* Cramer was the dominant species of this family which constituted 45.77% of total individuals of this family followed by *Princeps demoleus* Linnaeus (39.80%), *Papilio polytes* Linnaeus (6.96%), *Aporia aganthon* (6.46%) and *Atrophaneura dasarda* Moore (0.99%). Family Danaidae was represented by 3 species and constituted 8.10% of total collected butterflies. *Euploea core core* Cramer was the dominant species of this family which constituted 62.96% of total individuals of this family followed by *Danaus chrysippus chrysippus* Linnaeus (36.29%) and *Parantica sita* Stoll (0.740%). Family Lycaenidae was represented by 3 species and constituted 8.10% of total collected butterflies. *Zizeeria* sp. was the dominant species of this family which constituted 82.73% of total individuals of this family followed by *Talicada nyseus* (12.94%) and *Heliophorus sena* Kollar (4.31%). Family Scarabaeidae and Coccinellidae (each 1 species) constituted 2.70% of total collected butterflies. Family Apidae was represented by 2 species and constituted 5.40% of total collected insects. *Apis* sp. was the dominant species of this family which constituted 79.36% of total individuals of this family followed by *Bombus* sp. (20.63%). Family Libellulidae was represented by 2 species and constituted 5.40% of total collected insects. *Orthetrum, chrysis* was the dominant species of this family which constituted 62.5% of total individuals of this family followed by *Trithemis aurora* (37.5%). Family Calopterygidae and Chlorocyphidae (each 1 species) constituted 2.70% of the total collected insects. The results of this study shows that the crop fields are dominated by insect fauna. Few workers have studied abundance, insect populations and diversity obtained from agricultural ecosystem and the total of 39 individuals belonging to 6 orders and 6 families [17]. Few workers have studied diversity of insect pollinators of Rabi crops cultivated in surrounding areas of Barpeta Town in Assam, India [10]. Similarly, Insects have recorded from Kuwait 273 genera, 116 families, 19 orders during the study period (Wasnia Al Houty 2009). Similarly, other workers have recorded 77 species of insects belonging to 34 families and 4,501 insects from Wukari, Taraba State, Nigeria [12]. Few workers have reported 15 species of insects belonging to 9 families and 896 insects from District Sialkot, Pakistan [14]. Few workers have reported 19 species of insects belonging to 11 families and 5,955 insects from Bogor, Indonesia [1]. Similarly, few workers have studied 26 species of butterflies belonging to Pieridae family from Kumaun region, Uttaranchal [26]. Few workers have studied diversity, species richness and abundance of insect in crops from Kumaun, Uttarakhand [11]. Moreover, majority of the insects found in second year in comparison to first year. Diversity indices showed that Shannon-Wiener diversity index was highest in the first year (2.033) followed by second year (1.883). Evenness was highest in the first year (0.6101) followed second year (0.5386). Similarly, Margalef's index was highest in the second year (4.955) followed by first year (4.342) shown in Table 3. The present study has shown that Ramnagar is low in insect diversity. It has been predicted probably for the very first time in crops of Sawal Deh area of Ramnagar.

Table1. Taxonomic composition and number of individuals of different species of insects collected in the study area (Sawal Deh).

S. No.	Taxonomic Composition	Trophic level	Sawal Deh	
			First Year 2017-2018	Second Year 2018-2019
	Order: Lepidotera Family: Pieridae			
1.	*Pieris canidia* Evans	Herbivore	12	8
2	*Catopsilia pyranthe* Linnaeus	Herbivore	20	40
3.	*Catopsilia pomana* Fabricius	Herbivore	10	36
4.	*Pontia daplidice* Linnaeus	Herbivore	-	2
5.	*Eurema brigitta* Cramer	Herbivore	57	15
6.	*Colias electo fieldi* Menestries	Herbivore	-	6
7.	*Pieries brassicae* Linnaeus	Herbivore	42	19
8.	*Pareronia valeria* Cramer	Herbivore	4	-
9.	*Cepora nerissa* Fabricius	Herbivore	3	1
	Family: Nymphalidae			
10.	*Vanessa cashmirensis* Kollar	Herbivore	1	7
11.	*Cynthia cardui* Linnaeus	Herbivore	4	12
12.	*Sephisa dichora*	Herbivore	-	1
13.	*Precis lemonias* Linnaeus	Herbivore	50	32
14.	*Precis almana* Linnaeus	Herbivore	6	8
15.	*Precis orythia* Linnaeus	Herbivore	1	1
16.	*Precis iphita iphita* Cramer	Herbivore	4	-
17.	*Phalanta phalanta* Drury	Herbivore	-	5
18.	*Parathyma opalina* Kollar	Herbivore	-	4
	Family: Papilionidae			
19.	*Papilio protenor romulus* Cramer	Herbivore	60	32
20.	*Atrophaneura dasarada* Moore	Herbivore	-	2
21.	*Princeps demoleus* Linnaeus	Herbivore	30	50
22.	*Papilio polytes* Linnaeus	Herbivore	4	10
23.	*Aporia aganthon*	Herbivore	3	10
	Family: Danaidae			
24.	*Euploea core core* Cramer	Herbivore	50	35
25.	*Danaus chrysippus* Linnaeus	Herbivore	9	40
26.	*Parantica sita* Stoll	Herbivore	1	-
	Family: Lycanidae			
27.	*Heliophorous sena* Kollar	Herbivore	-	6
28.	*Zizeeria* sp.	Herbivore	50	65
29.	*Talicada nyseus*	Herbivore	13	5
	Order- Coleoptera Family: Scarabaeidae			
30.	*Sisyphus hirtus*	Scavenger	4	-
	Family: Coccinellidae			
31.	*Coccinella septumpuntata* Linnaeus	Predator	20	43
	Order- Hymenoptera Family: Apidae			
32.	*Apis* sp.	Herbivore	30	70
33.	*Bombus* sp.	Herbivore	6	20
	Order: Odonata Family: Libellulidae			
34.	*Trithemis aurora*	Predator	-	12
35.	*Orthetrum chrysis*	Predator	5	15
	Family: Calopterygidae			
36.	*Calopteryx maculate*	Predator	3	10
	Family: Chlorocyphidae			
37.	*Aristocypha aino*	Predator	-	16
	Total		502	638

Table2. Percent contribution of relative number of individuals and species of different families of insects recorded from the study area.

S.No.	Family	Number of species	% of species	Number of individuals	% of individuals
1	Pieridae	9	24.3	275	24.1
2	Nymphalidae	9	24.3	136	11.9
3	Papilionidae	5	13.6	201	17.6
4	Dainidae	3	8.10	135	11.8
5	Lycanidae	3	8.10	139	12.0
6	Scarabaeidae	1	2.70	4	0.3
7	Coccinellidae	1	2.70	63	5.5
8	Apidae	2	5.40	126	11.5
9	Libellulidae	2	5.40	32	2.8
10	Calopterygidae	1	2.70	13	1.1
11	Chlorocyphidae	1	2.70	16	1.4
	Total	37	100	1,140	100

Table3. Diversity indices of insect fauna of Sawal Deh area.

	2017-2018	2018-2019
No. of species	28	33
No. of individuals	502	638
Abundance	502	638
Shanon	2.033	1.883
Evenness	0.6101	0.5386
Margalef	4.342	4.955

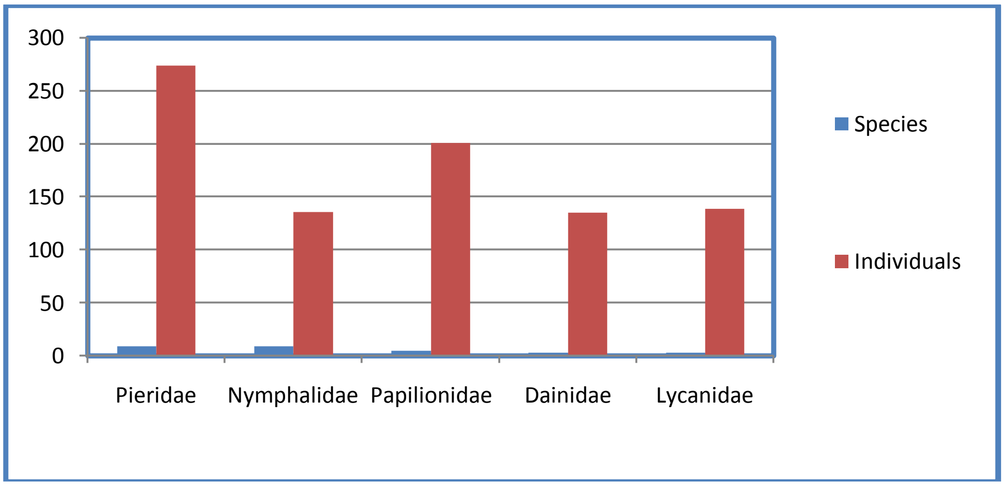
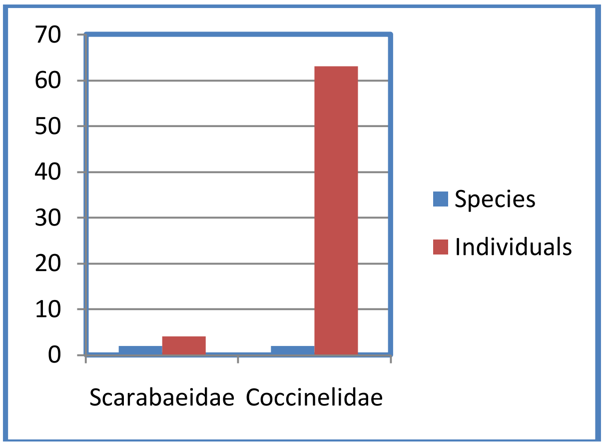
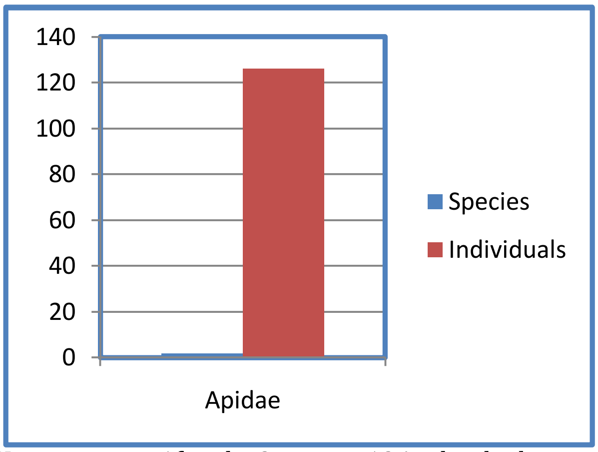


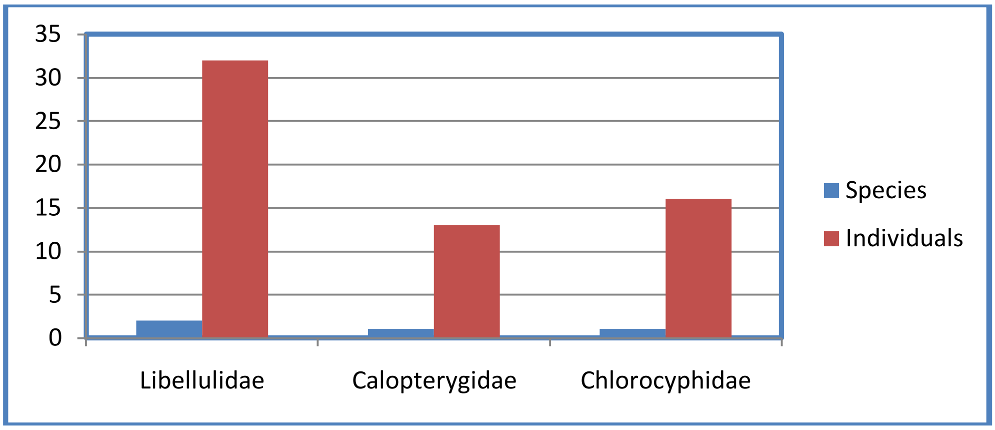
Fig. 3. Lepidotera-5 families, 29 species, 886 individuals



Coleoptera-2 families, 2species, 67 individuals



Hymenoptera-1family, 2species, 126individuals



Odonata-3 families, 4 species, 61 individuals

Fig.3. Graphical representation of different families obtained from each order

CONCLUSION

The results of present study indicate a decline in diversity, species richness and abundance of insects. Enhancement of pollinator insects as part of crop management should be considered by farmers and use of chemicals and use of angiosperm plants should be minimized for maintaining the biodiversity of insects. Study will assist all stakeholders to optimize the beneficial insects, while managing noxious species.

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Hymenopterans are largest and diversified assemblages of beneficial insects constitute the most important group of pollinating insect [20]. The present investigation evaluated the fluctuating diversity of insects of Sawal Deh area of Ramnagar and to analyze the relative impact of human activities. This study will help in learning a great deal about the behavior and relationships between insects and plants in the fields and will help in the management of ecosystems.

MATERIAL AND METHODS

Study Area: Ramnagar is located at 29.40^0 N 79.12^0 E. It has an average elevation of 345m (1,132 feet) and the state of Uttarakhand is situated between 28^0 53^0 24^0-31^0 27^0 50^0 N and 77^0 34^0 27^0-81^0 02^0 22^0 E. It is located approximately 65 km from Nainital, Uttarakhand. Ramnagar is located at the foothills of the Himalayas on the bank of river Kosi. Ramnagar being located in the center was selected to represent agro-ecosystem in mixed crop zone. A survey was made to select the crop fields of sugarcane, wheat, soybean, maize, paddy and mustard in Ramnagar, Uttarakhand (fig. 1 and fig. 2).

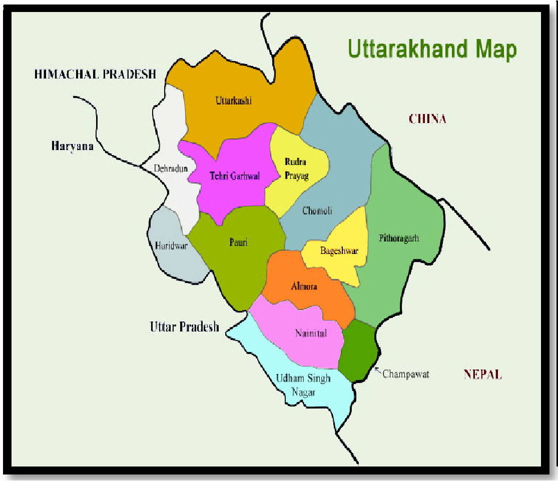


Fig.1. Map of Uttarakhand

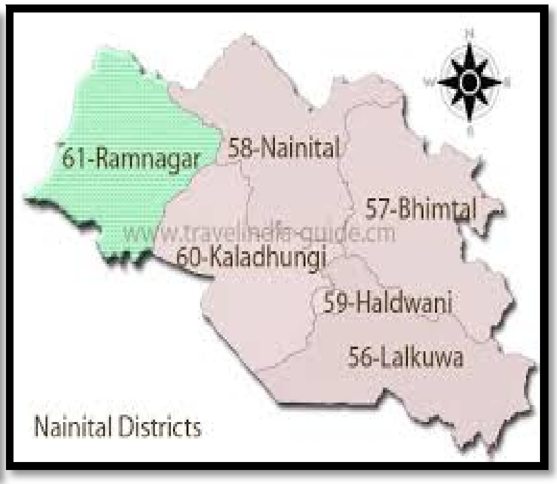


Fig.2. Map of study site

Sampling Site: The study site was Sawal Deh village which is located in Ramnagar Tehsil of Nainital district in Uttarakhand, India. It is situated 7 Km away from sub-district headquarter Ramnagar and 75 Km away from district headquarter Nainital. Paddy, wheat, mustard, soybean and maize are agriculture commodities grown in this village.

Sampling of Insects: Study was conducted from April 2017 to March 2019, in the selected field. The samples were collected from soil, ground surface, plants surface and air. Sweep net was used to sweep all types of insect fauna. The insects were collected by sweep sampling method [13]. Collection is done in each month by using standard protocols. For the collection of insects sweep sampling method, Hand picking, Shaking or beating and equipments were used. Hair brush, Forceps, Stick and Killing bottle were used collection and preservation of insects. The dead insects were transferred into boxes for temporary storage. The sacrificed insects were then properly pinned by steel pins and kept for proper drying. Naphthalene balls were placed inside the insect boxes to prevent from fungus. After the identification, the insects were labeled properly.

Data Analysis:

I. Shannon-Wiener diversity Index

The species diversity was calculated using Shannon Wiener Index (H)

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

Where, pi = fraction of total 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, i.e,

$$E = H/ \ln S$$

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

III. Margalef's Index

Species richness was calculated using Margalef's Index

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

Where, S = total number of species

N = total number of individuals in sample
In = natural logarithm

RESULTS AND DISCUSSION

A total 1,140 insects sample has been collected during months from April 2017 to March 2019. Overall, 4 orders, 11 families, 1,140 individuals of insects belonging to 37 species have been recorded during the study period in Table 1**.** According to the total number of species, dominant order is Lepidoptera (29 species) followed by Odonata (4 species), Coleoptera (2 species) and Hymenoptera (2 species) in fig. 3. Among order Lepidoptera, the family Pieridae and Nymphalidae were the most dominanted with 9 species each respectively, followed by Papilionidae (5 species), Danaidae and Lycaenidae each shared 3 species. Among order Coleoptera, the family Scarabaeidae and Coccinellidae each shared 1 species. Among order Hymenoptera, the family Apidae (2 species). Among order Odonata, the family Libellulidae (2 species), Calopterygidae and Chlorocyphidae each shared 1 species. Diversity indices, richness and evenness for three seasons were calculated in Table 3. Percent contribution of the relative number of individuals and species of different families of insects collected from study area are presented in Table 2. Among order Lepidoptera, the family Pieridae and Nymphalidae were the most dominant families which constituted 24.3% of the total collected insects. Family Pieridae, *Eurema brigtta* Cramer was the most dominant species of this family which constituted 26.18% of total individuals of this family followed by *Pieris brassicae nepalensis* Doubleday (22.18%), *Catopsilia pomana* Fabricius (18.18%), *Catopsilia pyranthe* Linnaeus (17.45%), *Pieris canidia canidia* Evans (10.18%), *Colias electo fieldi* Menestries (2.18%), *Pareronia valeria* Cramer (1.45%), *Cepora nerissa* Fabricius (1.45%) and *Pontia daplidice* Linnaeus (0.727%). Family Nymphalidae was the second most dominant family which constituted 24.3% of the total collected butterflies. *Precis lemonias* Linnaeus was the most dominant species of this family which constituted 60.29% of total individuals of this family, followed by *Cynthia cardui* Linnaeus (11.76%), *Precis almanac* Linnaeus (10.29%), *Venessa cashmirensis* Kollar (5.88%), *Phalanta phalanta* Drury (3.67%), *Precis iphita iphita* Cramer (2.94%), *Parathyma opalina* Kollar (2.94%), *Precis orythia* Linnaeus (1.47%) and *Sephisa dichora* (0.73%). Family Papilionidae was third most abundant family which constituted 13.6% of the total recorded individuals of insects and represented by 5 species. *Papilio protenor romulus* Cramer was the dominant species of this family which constituted 45.77% of total individuals of this family followed by *Princeps demoleus* Linnaeus (39.80%), *Papilio polytes* Linnaeus (6.96%), *Aporia aganthon* (6.46%) and *Atrophaneura dasarda* Moore (0.99%). Family Danaidae was represented by 3 species and constituted 8.10% of total collected butterflies. *Euploea core core* Cramer was the dominant species of this family which constituted 62.96% of total individuals of this family followed by *Danaus chrysippus chrysippus* Linnaeus (36.29%) and *Parantica sita* Stoll (0.740%). Family Lycaenidae was represented by 3 species and constituted 8.10% of total collected butterflies. *Zizeeria* sp. was the dominant species of this family which constituted 82.73% of total individuals of this family followed by *Talicada nyseus* (12.94%) and *Heliophorus sena* Kollar (4.31%). Family Scarabaeidae and Coccinellidae (each 1 species) constituted 2.70% of total collected butterflies. Family Apidae was represented by 2 species and constituted 5.40% of total collected insects. *Apis* sp. was the dominant species of this family which constituted 79.36% of total individuals of this family followed by *Bombus* sp. (20.63%). Family Libellulidae was represented by 2 species and constituted 5.40% of total collected insects. *Orthetrum, chrysis* was the dominant species of this family which constituted 62.5% of total individuals of this family followed by *Trithemis aurora* (37.5%). Family Calopterygidae and Chlorocyphidae (each 1 species) constituted 2.70% of the total collected insects. The results of this study shows that the crop fields are dominated by insect fauna. Few workers have studied abundance, insect populations and diversity obtained from agricultural ecosystem and the total of 39 individuals belonging to 6 orders and 6 families [17]. Few workers have studied diversity of insect pollinators of Rabi crops cultivated in surrounding areas of Barpeta Town in Assam, India [10]. Similarly, Insects have recorded from Kuwait 273 genera, 116 families, 19 orders during the study period (Wasnia Al Houty 2009). Similarly, other workers have recorded 77 species of insects belonging to 34 families and 4,501 insects from Wukari, Taraba State, Nigeria [12]. Few workers have reported 15 species of insects belonging to 9 families and 896 insects from District Sialkot, Pakistan [14]. Few workers have reported 19 species of insects belonging to 11 families and 5,955 insects from Bogor, Indonesia [1]. Similarly, few workers have studied 26 species of butterflies belonging to Pieridae family from Kumaun region, Uttaranchal [26]. Few workers have studied diversity, species richness and abundance of insect in crops from Kumaun, Uttarakhand [11]. Moreover, majority of the insects found in second year in comparison to first year. Diversity indices showed that Shannon-Wiener diversity index was highest in the first year (2.033) followed by second year (1.883). Evenness was highest in the first year (0.6101) followed second year (0.5386). Similarly, Margalef's index was highest in the second year (4.955) followed by first year (4.342) shown in Table 3. The present study has shown that Ramnagar is low in insect diversity. It has been predicted probably for the very first time in crops of Sawal Deh area of Ramnagar.

Table1. Taxonomic composition and number of individuals of different species of insects collected in the study area (Sawal Deh).

S. No.	Taxonomic Composition	Trophic level	Sawal Deh	
			First Year 2017-2018	Second Year 2018-2019
Order: Lepidotera				
Family: Pieridae				
1.	*Pieris canidia* Evans	Herbivore	12	8
2	*Catopsilia pyranthe* Linnaeus	Herbivore	20	40
3.	*Catopsilia pomana* Fabricius	Herbivore	10	36
4.	*Pontia daplidice* Linnaeus	Herbivore	-	2
5.	*Eurema brigitta* Cramer	Herbivore	57	15
6.	*Colias electo fieldi* Menestries	Herbivore	-	6
7.	*Pieries brassicae* Linnaeus	Herbivore	42	19
8.	*Pareronia valeria* Cramer	Herbivore	4	-
9.	*Cepora nerissa* Fabricius	Herbivore	3	1
Family: Nymphalidae				
10.	*Vanessa cashmirensis* Kollar	Herbivore	1	7
11.	*Cynthia cardui* Linnaeus	Herbivore	4	12
12.	*Sephisa dichora*	Herbivore	-	1
13.	*Precis lemonias* Linnaeus	Herbivore	50	32
14.	*Precis almana* Linnaeus	Herbivore	6	8
15.	*Precis orythia* Linnaeus	Herbivore	1	1
16.	*Precis iphita iphita* Cramer	Herbivore	4	-
17.	*Phalanta phalanta* Drury	Herbivore	-	5
18.	*Parathyma opalina* Kollar	Herbivore	-	4
Family: Papilionidae				
19.	*Papilio protenor romulus* Cramer	Herbivore	60	32
20.	*Atrophaneura dasarada* Moore	Herbivore	-	2
21.	*Princeps demoleus* Linnaeus	Herbivore	30	50
22.	*Papilio polytes* Linnaeus	Herbivore	4	10
23.	*Aporia aganthon*	Herbivore	3	10
Family: Danaidae				
24.	*Euploea core core* Cramer	Herbivore	50	35
25.	*Danaus chrysippus* Linnaeus	Herbivore	9	40
26.	*Parantica sita* Stoll	Herbivore	1	-
Family: Lycanidae				
27.	*Heliophorous sena* Kollar	Herbivore	-	6
28.	*Zizeeria* sp.	Herbivore	50	65
29.	*Talicada nyseus*	Herbivore	13	5
Order- Coleoptera				
Family: Scarabaeidae				
30.	*Sisyphus hirtus*	Scavenger	4	-
Family: Coccinellidae				
31.	*Coccinella septumpuntata* Linnaeus	Predator	20	43
Order- Hymenoptera				
Family: Apidae				
32.	*Apis* sp.	Herbivore	30	70
33.	*Bombus* sp.	Herbivore	6	20
Order: Odonata				
Family: Libellulidae				
34.	*Trithemis aurora*	Predator	-	12
35.	*Orthetrum chrysis*	Predator	5	15
Family: Calopterygidae				
36.	*Calopteryx maculate*	Predator	3	10
Family: Chlorocyphidae				
37.	*Aristocypha aino*	Predator	-	16
	Total		502	638

Table2. Percent contribution of relative number of individuals and species of different families of insects recorded from the study area.

S.No.	Family	Number of species	% of species	Number of individuals	% of individuals
1	Pieridae	9	24.3	275	24.1
2	Nymphalidae	9	24.3	136	11.9
3	Papilionidae	5	13.6	201	17.6
4	Dainidae	3	8.10	135	11.8
5	Lycanidae	3	8.10	139	12.0
6	Scarabaeidae	1	2.70	4	0.3
7	Coccinellidae	1	2.70	63	5.5
8	Apidae	2	5.40	126	11.5
9	Libellulidae	2	5.40	32	2.8
10	Calopterygidae	1	2.70	13	1.1
11	Chlorocyphidae	1	2.70	16	1.4
	Total	37	100	1,140	100

Table3. Diversity indices of insect fauna of Sawal Deh area.

	2017-2018	2018-2019
No. of species	28	33
No. of individuals	502	638
Abundance	502	638
Shanon	2.033	1.883
Evenness	0.6101	0.5386
Margalef	4.342	4.955

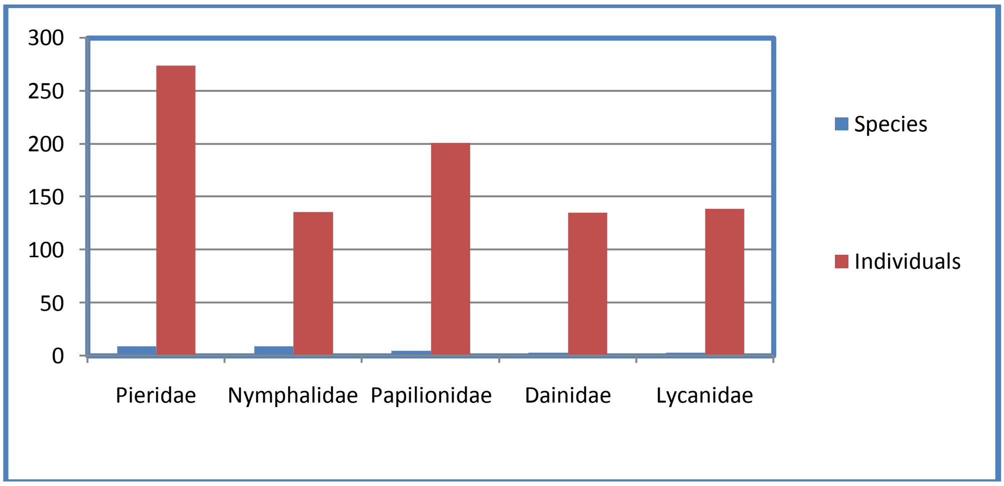
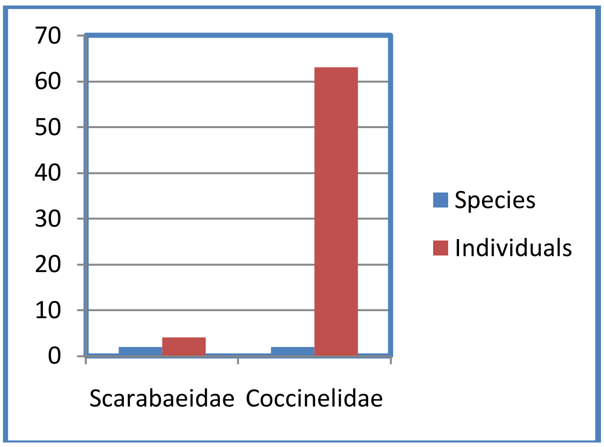
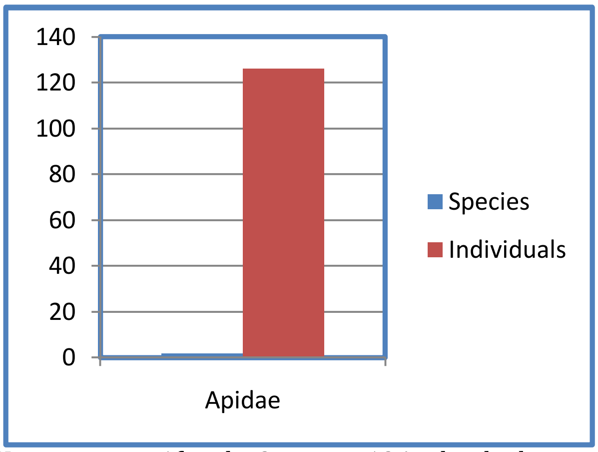


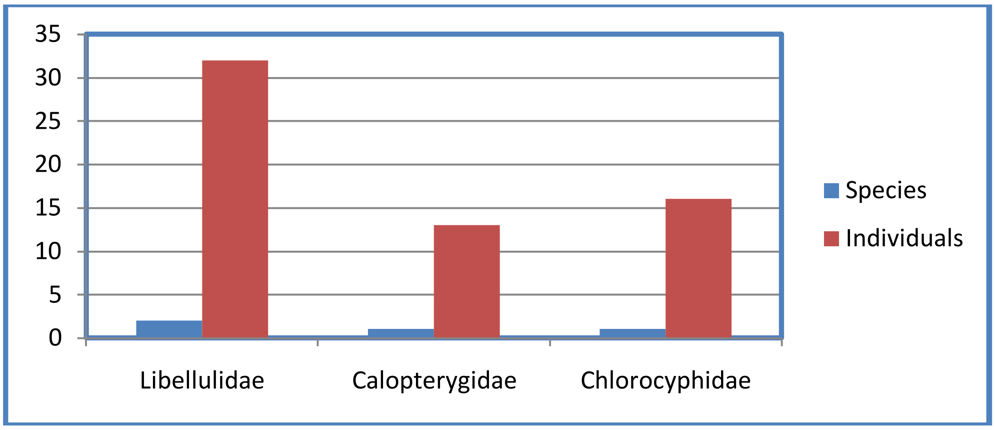
Fig. 3. Lepidotera-5 families, 29 species, 886 individuals



Coleoptera-2 families, 2species, 67 individuals



Hymenoptera-1family, 2species, 126individuals



Odonata-3 families, 4 species, 61 individuals

Fig.3. Graphical representation of different families obtained from each order

CONCLUSION

The results of present study indicate a decline in diversity, species richness and abundance of insects. Enhancement of pollinator insects as part of crop management should be considered by farmers and use of chemicals and use of angiosperm plants should be minimized for maintaining the biodiversity of insects. Study will assist all stakeholders to optimize the beneficial insects, while managing noxious species.

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