BIODIVERSITY AND SPECIES COMPOSITION OF LADY BIRD BEETLES (COCCINELLIDAE: COLEOPTERA) FROM MIRPUR DIVISION OF AZAD JAMMU & KASHMIR, PAKISTAN

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ABSTRACT

The present study reveals biodiversity (diversity, abundance, richness and evenness) and species composition of Ladybird Beetles from Mirpur Division of Azad Jammu and Kashmir, Pakistan. A total of fifty one species from 6 subfamilies were recorded from the study area. Further, there are thirty seven species of Ladybird beetles in district Mirpur, twenty nine in district Kotli and forty one in district Bhimber. Diversity was calculated by using Shannon-Wiener's diversity index and Simpson's index. Richness was calculated by Margalef's and Menhinick's Indices and evenness was calculated by Shannon-Wiener's Equitability Index, Pielou's index and Nakamuras's R-I index. The calculated values of diversity indices showed that highest diversity was recorded from district Bhimber and lowest from district Kotli. Diversity was also calculated for each locality of the three districts. In district Kotli, lowest diversity was calculated from Holar and highest diversity from Dhongi, in district Mirpur, the lowest diversity was calculated from Islamgarh and highest diversity from Jaltlan. Similarly in district Bhimber, the lowest diversity was calculated from Pindichunja and the highest from Bhimber city.

Keywords: Coccinellidae, biodiversity, species composition, Mirpur Division, Azad Jammu and Kashmir

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INTRODUCTION

Ladybird Beetles belong to the Family Coccinellidae and it is one of the large and important families in the Order Coleoptera. Ladybird beetles are mostly considered beneficial because of their predatory activity and help in regulating pest population of soft bodied insects like aphids, jassids etc. (Khuznetsov, 1997). However members of its subfamily Epilachninae are phytophagous and pests of important agricultural crops and feed almost exclusively on leaves of plant species belonging to the families Solanaceae, Cucurbitaceae, Fabaceae and Compositea (Dieke, 1947; Li and Cook, 1961).

Keeping in view the importance of coccinellid beetles in biological control, many workers attempted to explore the ladybird beetle fauna of Pakistan. Ghani (1963) provided a list of predatory beetles with some information on their biology and ecology. Ashrafi (1966) reported two species of epilachnine beetles from Karachi namely *Eplilachna sparsa* and *Epilachna chrysomelina*. Ghani *et al*. (1966) redescribed a new genus and species of Chilocorini from West Pakistan namely *Simmondsius pakistanensis*. Alam *et al*. (1969) explored coccinellids from different ecological zones of Pakistan. Ahmed (1973) reported a new tribe of the family Coccinellidae under the name *Ghanini*. CIBC (1982) reported seven species of epilachnine ladybird beetles from Pakistan. Similarly 16 species were recorded from Peshawar valley (Shah, 1983). Mughal *et al*. (1985) provided some taxonomic, distributional and biological information on these beetles for different areas of Pakistan. Recently Irshad (2001) and Rafi *et al*. (2005) described seventy five aphidophagous species of ladybird beetles from Pakistan

The work on coccinellid fauna of Azad Jammu and Kashmir is fragmentary. Farouq *et al.* (1999) and Khan *et al*. (1999) were first to initiate the work in this direction. Other works include; Inayatullah *et al*. (2005) with 16 species; Rafi *et al*. (2005) with 30 species and Khan *et al*. (2008) with 40 species.

The above review reveals that the coccinellid biodiversity of Azad Jammu & Kashmir is poorly studied in past. Keeping in view the importance of coccinellids there is a need to explore the coccinellid fauna of the region. The present study is an attempt in this direction. The present study reveals the species composition (diversity, abundance, richness & Evenness or equitability) of coccinellids in Mirpur division of Azad Kashmir, Pakistan.

MATERIALS AND METHODS

Study Area

Azad Jammu & Kashmir comprises of 3 divisions namely, Muzafarabad, Poonch and Mirpur. The study area Mirpur Division comprises of three districts namely Kotli, Mirpur and Bhimber. This study area is situated between 73 – 74 longitudes and 33 – 34 latitude with hilly type topography. The climatic conditions are sub-tropical type and elevation from Sea level ranges 1000 - 4000 ft approximately. Forty percent area is under cultivation and the main crops are maize, wheat & rice. Remaining 60% area consists of range lands, bush forests and pine forests.

Kotli districti is mainly a hilly area rising gradually towards the high mountains of Poonch District. Its climate is more moderate than that of Mirpur due to the sub-mountainous topography. River Poonch passes through it. The climate of the district is generally hot in summer and cold in winter. The Eastern and Northern parts are dry and cold. Whereas the western areas are a little hot. June is the hottest month with the mean maximum and minimum temperature of about 39 °C to 25 °C respectively. January is the coldest in month with the mean maximum and minimum temperatures of about 12 °C and −2 °C respectively. The mean annual rainfall is about 1,300 millimetres, more than half of which occurs during July and August.

Mirpur district is mainly mountainous with some plains. Its hot, dry climate and other geographical conditions closely resemble those of Jhelum and Gujrat, the adjoining districts of Pakistan.

Bhimber has a similar climate to the neighboring areas of Punjab, hot summer temperature is often over 45 ° C from May to September and cold winter, rainfall is concentrated in the monsoon from late June to the end of August. There is often a prolonged dry period form October to early January followed by winter rains from mid-January to March.

Collection of Specimens

The specimens were collected from the different localities (Fig.1) of the 3 districts of Mirpur division during 2008-2010 in their active season (March-December). These localities are: District Kotli: Kotli city, Holar, Sensah, Sarsawa, FatehPur, Khuiretta and Dongi. District Mirpur: Mirpur City, Dudial, Palak, Chak Sawari, Islam Garh, Mangla, Chockian, Jatlan, Chechian, Jery Kas. District Bhimber: Bhimber city, Samanhni, Choki, Pindi Chunjan, Berhing, Maghloora, Kadala, Barnala, Kot Jamel and Chumb. All sorts of localities were selected such as grassy patches, grassy fields, field crops, orchards, residential areas, lawns of the houses, grazing fields, bushes, forests with high trees, valleys, mountain peaks and alpine free zones.

Each locality was surveyed after one-month interval, starting from April to December. Ladybird beetle specimens were collected with the help of aerial nets and searching and hand picking method. Aerial net with 30 cm diameter, with white muslin cloth and one meter long handle was used. At each locality net sweeping was done 10 times while keeping hand stroke at shoulder level throughout. Collection was done between 10 am to 12 am. The collected specimens were brought to the laboratory for mounting/pinning and identification.

Identification

The identification was done with the help of literature and keys available such as Kapur (1958, 1965); Dieke (1947), Rafi et al. (2005) and Shunxiang (2010).

Calculation of Diversity Indices

The rank lists were prepared from each locality of each district by the help of which the diversity indices were calculated. A collective rank list along with the lists of taxa collected from each locality of each district was also prepared. To calculate the diversity of lady bird beetles, following 4 diversity indices were used:

Shannon- Wiener's diversity index (Shannon and Weiner, 1963): H= -I (pi)log2pi)

Where, "pi" is the proportion with in the sample of the number of the individuals of "ith" species and it is denoted by "ni/N", where, "ni" is the total number of individuals. But the form of the index used in the present study is:

$$H = C\{\log_{10} N - 1/N \ (nr\log_{10} nr)\},$$

Where, "N" is the total number of the individuals, "nr" is the rank abundance in "ith" species and "C" is the conversion factor from log2 to log10.

The form of the Shannon's equitability used is:

J=H/Hmax,

Where, "H" is the log2 of "S", where, "S" is the total number of species in the sample.

Shannon's equitability is derived from its diversity index and it is the ratio between the actual diversity of the sample and maximum diversity which occurs when all the species are equally abundant.

Margalef's Index (Margalef, 1968, 1969): D= S-1/Loge N,

Where, "S" is the number of species and "N" is the total number of individuals.

Simpson's Index (Simpson, 1949): D= I- (pi)

where, "pi" proportion of "ith" species and is calculated as " ni/N", where, "ni" is the number of individuals in "ith" species and "N" is the total number of individuals in the sample but the form of the index used in the present study is: D= { ni(ni-1/N (N-I)}, where, "ni" is the number of individuals in "ith" species and "N" is the total number of individuals in the sample.

Nakamura's RI Index (Nakamura and Toshima, 1995, 1999): RI= Ri/S(M-1)

Where, "S" is the number of investigated species of insects, where "S" is the number of rank of abundance (o,1,2,3……M-I) and "Ri" is the rank value of "ith" species in sample.

RESULTS AND DISCUSSION

During the present study 2889 specimens of lady bird beetles were collected from study sites which were identified into fifty one species under 26 genera from six subfamilies. Total number of specimens collected from district Kotli were 867, from district Mirpur 994 and from district Bhimber 1028. Thirty seven species from district Mirpur (Table 1), twenty nine from District Kotli (Table 2) and forty one from district Bhimber (Table 3) were identified.

Different indices were used to calculate diversity, richness, abundance and evenness. Diversity of Coccinellids was measured by using Shannon-Wiener's diversity index (Shannon- Wiener, 1963) and Simpson's index (Simpson, 1949), richness was measured by using Margalef's index (Margalef, 1968, 1969) and equitability was measured by Shannon's equitability index and Nakamura's RI index (Nakamura and Toshima, 1995, 1999).

Shannon-Wiener's diversity index (Shannon- Wiener, 1963) was used to calculate the biodiversity. This index measures abundance and richness components of diversity. The Shannon- Wiener's diversity index is distribution dependent and suffers least from criticism of validity in biological data (Gray, 1980).

The calculated values of Shannon- Wiener's diversity index at district Kotli ranged from 2.775 (Holar) to 4.127 (Dhongi). Remaining all the stations yielded the values in between above mentioned values. Most of the sites yielded the values near 4.0 (Kotli city, Sensah and Sarsawa) as shown in Fig. 1.

The values of this index from district Mirpur yielded the lowest values at Islam Garh (1.452) and highest values at Jatlan (4.220) whereas remaining all the stations yielded the values between them (Table 3). This index produce values for different the localities of district Bhimber ranged from 1.931 (Pindi Chunjan) to 4.382 (Bhimber city) and remaining all the stations yielded the values between these values (Fig. 2).

These results showed that ladybird beetles are well distributed almost at all the localities of these three districts of Azad Kashmir. However, the more densely vegetated sites (as Jatlan, Bhimber city area, Dongi, Sansah, Sarsawa) yielded slightly higher diversity values and barren and less vegetated areas yielded slightly lower diversity values. Simpson's index is used to measure the abundance of individual in the sampling unit or sampling area (Simpson, 1949). The value of Simpson index varies from 0 to 1 and if the value tends towards zero it indicates high diversity. This index is sample size dependent and values decrease with the increase in sample size. Therefore, it's reciprocal from I-D or I/D is usually used in ecological data. This ensures that the calculated values of index increase with increasing diversity (James and Shugart, 1970).

The calculated values of Simpson's diversity index (D) from district Kotli ranged between 0.078 (Jatlan) to 0.161 (Khuiretta). The calculated values of Simpson's diversity index (1-D) ranged from 0.839 (Khuiretta) to 0.917 (Fateh Pur). The value of this index for Fateh Pur & Holar (0.916) is very close. The calculated values of this index (1/D) ranged from 6.211(Khuiretta) to 12.821 (Sensah). Remaining all the sampled localities yielded the values of these indexes in between the above mentioned values (Fig. 1).

The calculated values of this index (D) from district Mirpur ranged from 0.069 (Jatlan) to 0.295 (Chockian). The calculated values of 1-D ranged from 0.705 (Chockian) to 0.931 (Jatlan). Similarly the calculated values of Index (1/D) ranged between 4.225 (Jerry Kas) to 14.493 (Jatlan). The species abundance was highest in Jatlan and lowest in Jerry Kas among all the districts visited in this Division. All the remaining values of these indexes ranged in between the maximum and minimum of each index (Fig. 2).

The calculated values of this index (D) at different localities of District Bhimber ranged between 0.077 (Maghlora) to 0.193 (Choki). The values of this index are not varying much in the region among other districts. As this is quite close to the calculated values obtained from District Kotli. Similarly the calculated values of index (1-D) ranged from 0.807 (Choki) to 0.911 (Bhimber city) and the calculated values for the index (1/D) 5.181 (Choki) to 11.236 & 12.987 (Bhimber & Maghlora respectively) (Fig. 3).

Margalef's index (Margalef, 1968, 1969) was used to measure richness from different localities of districts of Mirpur Division.

The calculated values of Margalef's index from Kotli ranged from 3.282 (Dhongi) to 4.002 (Sensah). Remaining all the sites yielded the values in between these two (Table 1). The yielded values of this index from all the localities visited indicate that there is no big difference in the species richness of coccinellid beetles in this district.

Margalef's index produced values for district Mirpur ranged from 1.978 (Chockian) to 3.890 (Jatlan). Remaining all the sites yielded the values in between these two). This indicates that the species richness is lower at Chockian and higher in Jatlan. Most of the sites yield the value around 3.0 (Fig. 2).

The calculated values of Margalef's index from Bhimber ranged from 1.839 (Pindi Chunjan) to 5.029 (Bhimber city). Remaining all the sites yielded the values in between these two (Fig. 3). Bhimber city has the highest species richness among all the districts visited in this Division.

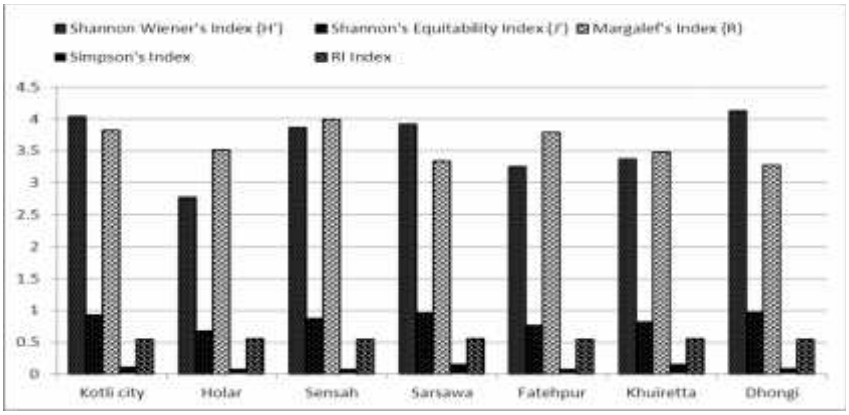

Fig. 1 Calculated Values of Diversity Indices from different localities of district Kotli

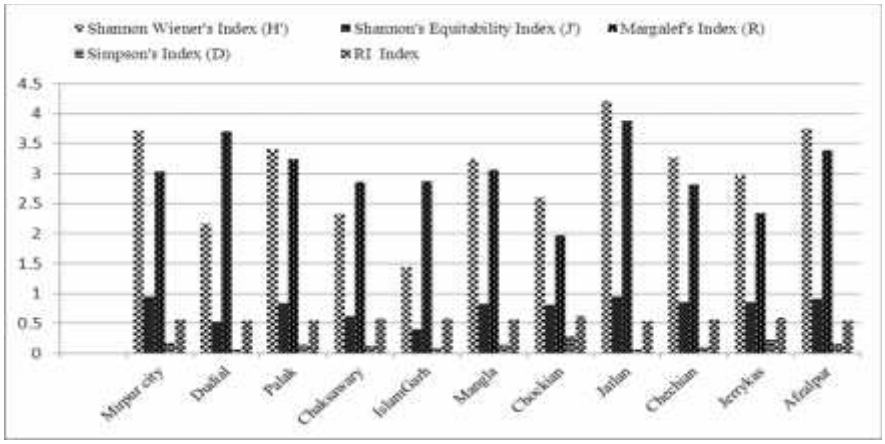

Fig. 2 Calculated Values of Diversity Indices from different localities of district Mirpur.

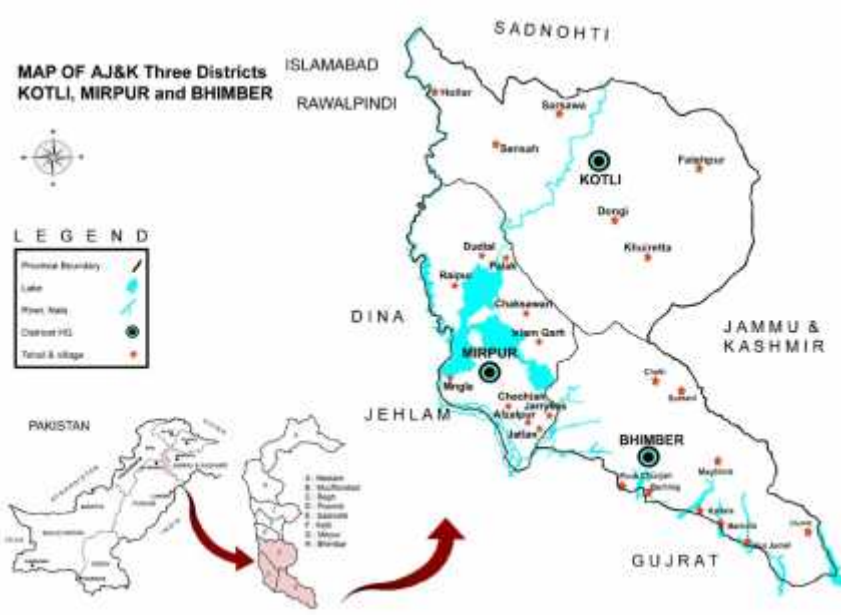

Fig. 3 Map of different districts of Mirpur Division showing the sampled sites.

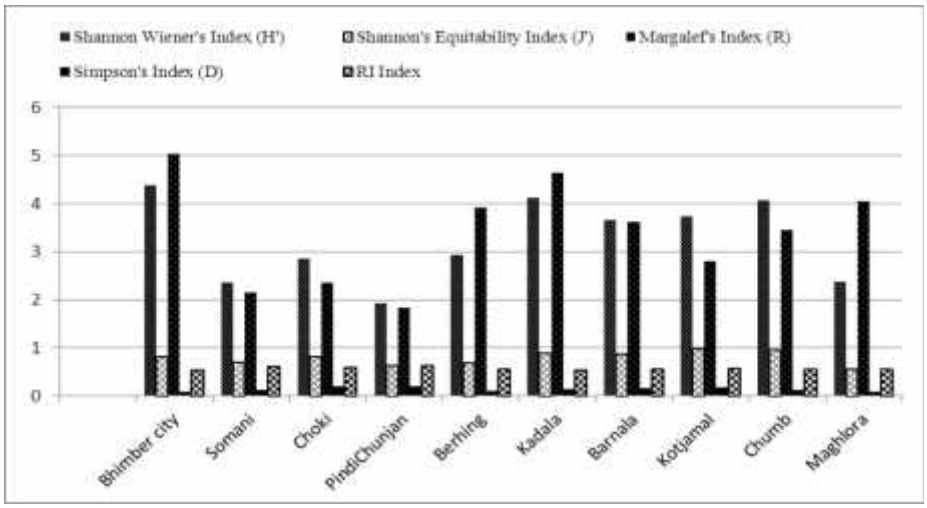

Fig. 4 Calculated Values of Diversity Indices from different localities of district Bhimber

Table 1. Collective Rank list along with the lists of Species collected from different localities of District Kotli, Azad Kashmir.

Rank	Names of Species	Abundance	Kotli city	Holar	Sensah	Sarsawa	Fatehpur	Khuiretta	Dongi
1	Coccinella septempunctata	165	40	15	25	8	22	35	20
2	Psyllobora bisoctonotata	94	3	8	15	22	15	10	21
3	Cheilomenes sexmaculata	89	19	14	12	10	7	3	24
4	Anegleis cardoni	71	7	3	10	39	4	4	4
5	Scymnus nubilus	60	5	12	10	3	1	6	23
6	Oenopia sauzeti	52	6	4	15	4	14	3	6
7	Hippodamia variegate	50	8	5	6	5	7	13	6
8	Hormonia dimidiata	44	5	7	5	4	6	7	10
9	Coccinella transversalis	36	10	7	3	6	3	3	4
10	Brumoides suturalis	24	5	3	3	4	1	5	3
11	Oenopia mimica	22	3	2	4		7	2	4
12	Oenopia conglobate	21	10	1	3	1	1	2	3
13	Stethorus gilvifrons	19		2	2	4	6	1	4
14	Calvia punctate	15	2	2		1	4	2	4
15	Scymnus posticalis	15	1		2	3	6	1	2
16	Serangium montazerii	15			15				
17	Propylea dissecta	12	5		2	2	2	1	
18	Serangium parcesetosum	10			8				2
19	Stethorus pauperculus	8		3	1		3	1	
20	Chilocoru sinfernalis	7			2	1	4		
21	Illeis timberlakei	6			3				3
22	Henosepilachna septima	6		4					2
23	Macroilleis hauseri	5	3				2		
24	Adalia tetraspilota	5	5						
25	Henosepilachna vigintioctopunctata	5	2						3
26	Rodolia ruficollis	4	2	2					
27	Hyperaspis quardimaculata	3	3						
28	Chilocorus melas	2			2				
29	Platynaspidius saundersi	2				2			
	No of Individuals	N=867	N=144	N=94	N=148	N=119	N=115	N=99	N=148
	No of Species		20	17	21	17	19	17	19

Table 2. Collective Rank list along with the lists of Species collected from different localities of District Mirpur, Azad Kashmir.

Rank	Names of Species	Abundance	Mirpur city	Dudial	Palak	Chaksawary	IslamGarh	Mangla	Chockian	Jatlan	Chechian	Jerrykas	Afzalpur
1	Coccinella septempunctata	213	25	11	35	15	10	8	30	22	20	32	5
2	Cheilomenes sexmaculata	142	25	6	9	7	6	32	3	13	13	5	23
3	Hippodamia variegate	127	22	8	5	3	2	6	4	20	17	5	35
4	Anegleis cardoni	57		5	2	3	5	6	4	15	10	5	2
5	Scymnus nubilus	56	5			14		5		15	5	10	2
6	Hormonia dimidiate	47		10	10	5	4	3		8			7
7	Coccinella transversalis	47		5	10	8	5	4	3				12
8	Psyllobora bisoctonotata	37	4	1	2		1	8		16	3		2
9	Oenopia sauzeti	35	4	2	2	1	4	2	2	5	7	4	2
10	Oenopia conglobate	29	4	2	5	1		4		7		4	2
11	Propylea dissecta	27	2	1		1		4		10	7		2
12	Brumoides suturalis	25	1				3	10		5			6
13	Oenopia mimica	19			2		2	1		8	6		
14	Calvi apunctata	18		3	5	2					3	2	3
15	Stethorus gilvifrons	18		8	3		2	1		2			2
16	Illeis timberlakei	16	1	2	6	3				4			
17	Chilocorus infernalis	15	2		3				4	4		2	
18	Coelophora bisellata	8	1	2							5		
19	Scymnus posticalis	7			2		2			2		1	
20	Stethorus pauperculus	6		2				2					2
21	Coccinella undecimpunctata	5							5				
22	Henosepilachna vigintioctopunctata	5								5			
23	Platynaspidius saundersi	5								5			
24	Palaeoneda auriculata	5		5									
25	Micraspis allardi	5		2									3
26	Adalia tetraspilota	4	2							2			
27	Hyperaspis quardimaculata	3							2			1	
28	Halyzia tschitscherini	3				3							
29	Rodolia ruficollis	2								2			
30	Illeis indica	1									1		
31	Scymnus latemaculatus	1	1										
32	Scymnus coccivora	1								1			
33	Pricibrumus uropygialis	1											1
34	Exochomus nigripennis	1									1		
35	Stethorus yuniensis	1	1										
36	Sasajiscymnus perpusillus	1									1		
37	Propylea quatuordecimpunctata	1			1								
	No of Individuals	N=994	N=100	N=75	N=102	N=66	N=46	N=96	N=57	N=171	N=99	N=71	N=111
	No of Species		15	17	16	13	12	15	9	21	14	11	17

Table 3. Collective Rank list along with the lists of Species collected from different localities of District Bhimber, Azad Kashmir.

Rank	Names of Species	Abundance	Bhimber city	Somani	Choki	Pindi Chunjan	Berhing	Kadala	Barnala	Kotjamal	Chumb	Maghlora
1	*Coccinella septempunctata*	240	30	15	20	15	25	45	29	26	20	15
2	*Cheilomenes sexmaculata*	187	28	7	11	8	15	19	31	32	30	6
3	*Hippodamia variegate*	98	4	12	5	10	10	18	8	10	19	2
4	*Psyllobora bisoctonotata*	59	25			2	2	2	6	3	7	12
5	*Coccinella transversalis*	45	13	4	3	4	3		3	3	5	7
6	*Micraspis allardi*	44	1		20			5	3		9	6
7	*Propylea dissecta*	33	1		2	2	2	5	2	2	15	2
8	*Oenopia sauzeti*	31	5	6	2	2	2	3	2	5	1	3
9	*Oenopia conglobate*	30	9				7	2	3	6	2	1
10	*Scymnus nubilus*	27	7		2			7	1	2	2	6
11	*Hormonia dimidiate*	26	8	4			3	7	1			3
12	*Anegleis cardoni*	24	5					2	4	5	5	3
13	*Brumoides suturalis*	20	2		2		2	3	2		7	2
14	*Chilocorus infernalis*	18	6					4	5		3	
15	*Calvia punctate*	17	5	5			2	2	3			
16	*Stethorus gilvifrons*	15	4		1		4	2		2		2
17	*Oenopia mimica*	14	7	6						1		
18	*Henosepilachna vigintioctopunctata*	14		3			5	3			3	
19	*Coelophorabisellata*	12	2	2	1		3	2			2	
20	*Stethoru spauperculus*	11	3				2	1		3		2
21	*Coccinella undecimpunctata*	7										7
22	*Adalia tetraspilota*	6	2				2	2				
23	*Henosepilachna septima*	6					2		2			2
24	*Scymnus posticalis*	5						2			3	
25	*Illeis timberlakei*	4	2					2				
26	*Halyzia tschitscherini*	4	1				3					
27	*Hyperaspis quardimaculata*	4									4	
28	*Henosepilachna ocellata*	4					4					
29	*Pricibrumu suropygialis*	4							2			2
30	*Henosepilachna boisduvali*	4							2			2
31	*Platynaspidius saundersi*	3								3		
32	*Illeis confuse*	2				2						
33	*Illeis shinensis*	2	2									
34	*Micraspis vincta*	1	1									
35	*Halyzia sanscrita*	1	1									
36	*Afidentula bisquardipunctata*	1	1									
37	*Exochomus nigripennis*	1									1	
38	*Exochomus flavipes*	1	1									
39	*Serangium parcesetosum*	1						1				
40	*Rodolia ruficollis*	1						1				
41	*Sumnius vestita*	1						1				
	No of Individuals	N=1028	N=176	N=64	N=69	N=45	N=98	N=141	N=109	N=103	N=138	N=85
	No of Species		27	10	11	8	19	24	18	14	18	19

The equitability component of diversity was calculated by using two indices namely; Shannon's equitability index and Nakamura's RI index (Nakamura and Toshima, 1995, 1999). The Shannon's equitability's calculated values from district Kotli ranged from 0.679 (Holar) to 0.971 (Dhongi) and remaining all the sites yielded the values between these two (Table 1). Whereas from Mirpur district the lowest equitability values were obtained from Islam Garh (0.405) and the highest equitability values were obtained from Jatlan (0.961). Remaining all the sites yielded the equitability values ranged in between these values (Fig. 1).

The results of Shannon's equitability index from district Bhimber ranged from 0.559 (Maghlora) to 0.978 (Kot Jamal). Remaining all the sites yielded the values in between these two (Fig. 3), which means the equitability of the ladybird Beetles from all the three districts of Azad Kashmir is not very much different from each other.

The second index used to measure the equitability component during the present study is Nakamura and Toshima's index (RI) which measure the richness of the species. The calculated values of Nakamura and Toshima's index ranges from 0 to 1. If the values are closer to zero it indicates that more species are present in the sample (Nakamura and Toshima, 1999).

The calculated values of this index from district Kotli ranged between 0.550 (Sensah) to 0.562 (Sarsawa & Khuiretta). Remaining all the sampled localities yielded the values in between these two (Table 1). This indicates that the number of species and individuals in not very much different at all the sampled sites of this district.

The calculated values of this index from district Mirpur ranged from 0.550 (Jatlan) to 0.625 (Chockian) (Table 3) and for district Bhimber the values of this index ranged between 0.543 (Kadala) to 0.642 (Pindi Chunjan) (Fig. 3). Lady bird beetles are most familiar predators of coccids, aphids and other small and soft insects. From the study area both predator and pest species are found and their diversity and abundance was calculated. *Coccinella septempunctata* is a predator and the most abundant species in the area. The most rare species recorded were *Sasajiscymnus perpusillus* **Sp. nov**.(Alia, 2014), *Propylea quaturodecimpunctata* (Linnaeus, 1758), *Stethorus yunnaniensis* (Pang and Mao, 1975), *Exochomus nigripennis* (Erichson, 1843),, *Exochomus flavipes* (Thunberg, 1781), *Sumnius vestita* (Mulsant, 1850) , *Rodalia ruficollis* Mulsant, 1853, *Micraspis vincta* (Gorham, 1895), *Scymnus coccivora* Ayyar, 1925 and *Scymnus latemaculatus* (Motschulsky, 1858).

CONCLUSIONS AND RECOMMENDATIONS

Present study is the first of this type of study on the diversity of coccinellids and its ecological study in the area. The values of Margalef's Index indicating species richness reveals that highest number of species are occurring in the surroundings of Bimber city which is mainly covered by wild vegetation of Custard plants and Akk plants in addition to field crops. Rare species of coccinellids were only found around Bimber city and Kadala. Margalaf's index is best among indices providing best information followed by Shanon Wiener's index. However variety of indices were used for calculation of one attribute of biodiversity because the value of one index is not reliable.

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