



Research Article

BIODIVERSITY OF COCCINELLIDS UNDER NORTH GUJARAT CONDITIONS

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Abstract- A survey on biodiversity of coccinellids in different ecosystems of Sardarkrushinagar indicated the presence of 15 different coccinellid species belonging to 6 different sub families. *Cheilomenes sexmaculatus* Fabricius was found to be the predominant species. Majority of the species belonged to sub family Coccinellinae representing 40% of the total species collected, followed by Chillocorinae (20%) and Epilachinae (20%). The forest ecosystem contained diverse group of coccinellids, as 5 out of 6 subfamilies were found. Agro ecosystem was recorded with maximum species richness followed by horticulture and forest ecosystem. Based on the Shannon index values, coccinellids shared highest diversity during December, in agro ecosystem, November in horticulture and forest ecosystem of the study area. The diversity of coccinellids was comparatively low during April, June and July in agro ecosystem. In horticulture ecosystem, the least population was recorded during May and July whereas in forest ecosystem during February to September.

Keywords- Biodiversity, Species richness, Species evenness, Shannon diversity index

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Introduction

Biodiversity underpins the form and function of ecosystem, which are of high value due to the life supporting services they provide. Insects are important because of their diversity, ecological role and influence on agriculture, human health and natural resources. 6000 species of coccinellids had been reported worldwide [1]. In India, Coleoptera accounts for about 15,289 species [2]. The checklist of the coccinellidae in India revealed about 510 species including Epilachinae under 79 genera [3]. A total number of 261 predaceous coccinellids belonging to 57 genera was also reported in India [4]. Variation in population index of different coccinellid species in Punjab could be attributed to deviation in aphid population, environmental factors and plant characteristics [5]. Diversity, distribution and habitat preference of coccinellids revealed the presence of 24 species under 17 genera in Tripura indicating the richness and species diversity is more in forest area compared to agro ecosystem [6]. 9 different coccinellid species were recorded in Anand region of Gujarat [7] and same number was also reported from Navsari, south Gujarat [8]. No published information is available on its diversity from North Gujarat.

Materials and Methods

The study area was situated at 24°19' N latitude and 72°19' E longitude with an elevation of 154.52 m above the mean sea level, representing north Gujarat Agro climatic zone. The average maximum monthly temperature ranged between 35 and 41°C, while minimum varied from 7 to 11°C. The field observations and collection of insects were made from different ecosystems of Sardarkrushinagar during 2013–2014. A fixed plot survey was conducted in three different ecosystems viz., agro-ecosystem (Agronomy Instructional Farm), horticulture ecosystem (Horticulture Instructional Farm) and forest ecosystem (Center for Agro forestry forage crops and green belts) to study the biodiversity parameters. A roving survey was also carried out to prepare an inventory. The survey was done

in all the three seasons viz., *kharif*, *rabi* and summer. Weekly observations were made from 100 plants/trees from each season and computed to monthly average [10]. The plants were closely observed for coccinellids and were collected by hand picking, visual encounters and aspiration methods [9]. The specimens were further sent to identification to National Bureau of Agriculturally Important Insects, Bengaluru and Indian Agricultural Research Institute, New Delhi.

Biodiversity

The data generated from the monthly fixed site survey was subjected to statistical analysis to determine the various indices and aspects of diversity viz., Species richness, Species evenness and Shannon-index as per the following formula.

Species richness

Species richness refers to the number of species collected in every effort (month) at different ecosystems and maximum species collected over a period [11].

$$N_0 = S \quad [Eq-1]$$

Where,

N_0 = Number of species observed

R_1 = Richness index (Margalef index)

S = Total number of species observed in every effort

n = Total number of individuals

$\ln$ = Natural logarithm of n

Species evenness

The index describes the distribution or equality of a species in a sample. This index quantifies how equal the species are numerically in an ecosystem, which is calculated by following formula [12].

$$E_1 = \ln(N_1) / \ln(N_0)$$

[Eq-2]

Where,

$$N_1 = e^{H^1}$$

N₀ = Number of species observedH¹ = Shannon's index

Diversity index (H¹)

In order to study the proportion of each species within the local community, species diversity was computed based on Shannon-Wiener formula which is also known as the Shannon index [13].

$$H^1 = - \sum_{i=1}^S P_i \log_e P_i$$

[Eq-3]

Where,

H¹ = Shannon biodiversity indexP_i = the proportional abundance of ⁱth specieslog_e P_i = the natural log of P_i and

S = total number of species in the community

Statistics

All the data collected and information generated was tabulated and statistically analyzed to calculate the diversity indices.

Results

Inventory and taxonomic composition of coccinellids in Sardarkrushinagar

15 species of coccinellids belonging to 6 sub families were recorded from the study area. The list of the coccinellids collected in three different ecosystems during the study period and total number of individuals collected has been given in the [Table-1] and [Fig-1] respectively.

A perusal of the data indicated that, highest number of species was observed in agro ecosystem (9) followed by Horticulture ecosystem (8) and forest ecosystem which represented least number of 7 species. Among the species, *Cheilomenes sexmaculatus* Fabricius was active in all 3 ecosystems indicating a wide adaptability, whereas the coccidophagous insects like *Exochomus* spp, *Pharoscyrmushornii* Weise and *Rodolia* spp. were observed only in forest ecosystem; Again *Coccinella transversalis* Fabricius was the only species that occurred exclusively indicating its suitability to agro ecosystem. The phytophagous coccinellids, *Epilachnaocellata* Redtenbacher, *Epilachnavigintioctopunctata* Motschulsky and *Henosepilachna elaterii* Rossi were active only in horticulture ecosystem signifying its adaptability to vegetable crops.

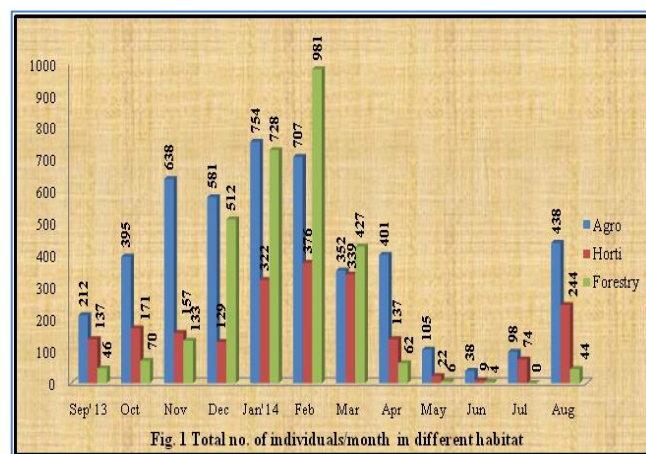


Fig-1 Total no. of coccinellids observed per month

Biodiversity of coccinellids in different ecosystems of Sardarkrushinagar

Species diversity in a given area consists of two components viz., species richness and species evenness or equitability. The former is the number of species in the community, whereas the latter is referred to as the number of individuals distributed among species with reference to its relative abundance. A study was undertaken during 2013 – 14 in three different ecosystems of S.D. Agriculture University campus, Sardarkrushinagar to assess the diversity of coccinellids and its distribution among communities through diversity indices and evenness values.

Agro ecosystem

The various diversity indices derived over a period of population assessment in an agriculture ecosystem has been given in [Table-2]. A perusal of the data depicted in the table indicated that, species richness in agriculture ecosystem varied from 3 – 9 among different months. December – 13 and January 14 recorded highest species richness followed by November (8) and August (7). During September, February, May and June recorded 5 species of coccinellids in agriculture ecosystem and it was least during July (3) and March (4).

The total number of individuals recorded over sequential months has been given in [Fig-1]. Considering the R₁ values January was the most species rich month. Among September, February, May and June where number of species observed was same (5), however considering the R₁ value, February 2014 was more species rich month (R₁ – 0.61), indicating more number of individuals were active in February.

Table-1 Inventory and taxonomic composition of coccinellids in different habitats of Sardarkrushinagar

S. No.	Name of the species	Sub family	Ecosystems		
			Agro.	Horticulture	Forest
1.	<i>Brumoidessuturalis</i> Fabricius	<i>Chilocorinae</i>	+	+	-
2.	<i>Chilocorus</i> sp.	<i>Chilocorinae</i>	+	-	+
3.	<i>Coccinellaseptumpunctata</i> Linnaeus	<i>Coccinellinae</i>	+	+	-
4.	<i>Coccinella transversalis</i> Fabricius	<i>Coccinellinae</i>	+	-	-
5.	<i>Epilachnaocellata</i> Redtenbacher	<i>Epilachinae</i>	-	+	-
6.	<i>Epilachnavigintioctopunctata</i> Motschulsky	<i>Epilachinae</i>	-	+	-
7.	<i>Exochomus</i> sp.	<i>Chilocorinae</i>	-	-	+
8.	<i>Henosepilachnaelaterii</i> Rossi	<i>Epilachinae</i>	-	+	-
9.	<i>Hippodamia variegata</i> Mulsant	<i>Coccinellinae</i>	+	+	-
10.	<i>Illeis</i> sp.	<i>Coccinellinae</i>	+	+	-
11.	<i>Cheilomenes sexmaculatus</i> Fabricius	<i>Coccinellinae</i>	+	+	+
12.	<i>Pharoscyrmushornii</i> Weise	<i>Sticholotidinae</i>	-	-	+
13.	<i>Propyleadissecta</i> Mulsant	<i>Coccinellinae</i>	+	-	+
14.	<i>Rodolia</i> sp.	<i>Coccidulinae</i>	-	-	+
15.	<i>Stethorus</i> sp.	<i>Scymninae</i>	+	-	+
Total			9	8	7

+ Presence; - Absence

The monthly species evenness index, computed for agriculture ecosystem has been presented in [Table-2]. A perusal of the data depicted in the table indicated

that evenness value varied from 0.57 (April) to 0.97 (July) indicating that species were evenly distributed in the month of July, where as it was sparse in April, even

though species richness in the month of April was high. During December and January, the evenness values were, 0.89 and 0.68 respectively. However, in both the months, number of observed species was same (9). This explains that, during December the number of species were more evenly distributed compare to January, where one or more species may be dominant in the community. Diversity index incorporate both species richness and evenness into a single value. The most commonly used diversity index i.e., Shannon index was calculated over 12 months and presented in [Table-2]. The data depicted, clearly

shows that diversity index varied from a lowest value of 1.03 in the month of April to a highest value of 1.95 in the month of December, indicating the lowest and highest diversity period respectively.

As per the index values, it can be inferred that April (1.03), June (1.05) and July (1.07) were the lowest diverse months for coccinellids, whereas its diversity was moderately high in the month of December (1.95), August (1.70), November (1.69) and October (1.54).

Table-2 Diversity indices of coccinellids in various ecosystems during 2013 – 14

S. No.	Month	Agro ecosystem				Horticulture ecosystem				Forest ecosystem			
		(N ₀)	(R ₁)	(E ₁)	(H' ₁)	(N ₀)	(R ₁)	(E ₁)	(H' ₁)	(N ₀)	(R ₁)	(E ₁)	(H' ₁)
1	Sep. 13	5	0.75	0.76	1.22	4	0.61	0.83	1.15	2	0.26	0.42	0.29
2	Oct.	7	1.00	0.79	1.54	6	0.97	0.77	1.38	4	0.71	0.74	1.02
3	Nov.	8	1.08	0.81	1.69	6	0.99	0.83	1.49	6	1.04	0.81	1.45
4	Dec.	9	1.26	0.89	1.95	6	1.03	0.70	1.26	6	0.81	0.63	1.12
5	Jan. 14	9	1.21	0.68	1.50	7	1.04	0.76	1.47	5	0.61	0.78	1.25
6	Feb.	5	0.61	0.83	1.33	5	0.67	0.87	1.4	5	0.58	0.52	0.83
7	Mar.	4	0.51	0.96	1.33	6	0.86	0.68	1.21	4	0.50	0.45	0.62
8	Apr.	6	0.86	0.57	1.03	6	1.01	0.88	1.57	2	0.48	0.88	0.61
9	May	5	0.86	0.86	1.38	2	0.32	1.00	0.69	1	1.44	0.00	0.69
10	Jun.	5	1.10	0.65	1.05	3	0.91	0.96	1.06	1	0.00	0.00	0.00
11	Jul.	3	0.44	0.97	1.07	3	0.46	0.86	0.95	0	0.00	0.00	0.00
12	Aug.	7	1.00	0.87	1.70	4	0.54	0.99	1.37	2	1.44	1.00	0.69

Horticulture ecosystem

The various diversity factors computed for horticulture ecosystem has been presented in [Table-2]. The data illustrated that species richness varied from 2 to 7 among various months. The highest number of coccinellid species were active in the month of January 2014 (7) followed by October, November, December, March and April where 6 species each was observed. Among these months, even though observed number of species was same, considering the R₁ values the species richness was highest in March (R₁ – 0.86) and lowest in April (R₁ – 1.01).

The distribution pattern of coccinellids in horticulture ecosystem was studied and evenness values have been illustrated in [Table-2]. A perusal of the data indicated that evenness values varied from 0.68 in the month of March to a highest of 1.00 in May, wherein the number of species observed varied from 6 to 2. The data clearly indicated that in spite of the existence of more number of species during March, the species were not evenly distributed. However in the month of March, the maximum evenness values were observed where all the observed species were equally distributed. But the total number of species observed was only two during January, the number of observed species were 7 (highest) in horticulture ecosystem and observed an evenness value of 0.96 which is an ideal situation where almost all available species were equally distributed.

The diversity index value in horticulture ecosystem varied from a lowest of 0.69 in the month of May to a highest of 1.57 in the month of April. The lowest diversity index values in the month of May (0.69), July (0.95) and June (1.06) was also an indication of lowest species richness observed in these months.

Forest ecosystem

The diversity index values for forest ecosystem computed for a period of September 2013 to August 2014 depicted in [Table-2]. The data showed the presence of highest number of 6 species in the ecosystem during November and December. The number of observed species varied from 1 to 6 among various months. During July, the number of coccinellid species was active in forest ecosystem. The number of observed species were comparatively low in the month of May (1), June (1), August (2), September (2) and April (2), however the number of species were more prevalent in November (6), December (6), January (5), February (5) and October (4). Considering R₁ values, the species richness was highest in the month of December (R₁ – 0.81), followed by February (0.58). During October and March, even though the observed species are same, considering the R₁ values, February is more species rich.

The evenness value presented in [Table-2] revealed that in the month of November, species were more or less evenly distributed (0.81), compared to

December (0.63) in spite of both the months, the total number of species observed were same. The data on evenness values indicated that in forest ecosystem the species were unevenly distributed, with maximum evenness observed in the month of August (1). Where in the observed species was only two.

Shannon index values showed in [Table-2] revealed that the diversity index varied from a lowest value of 0.29 to a highest value of 1.49 in the month of November. The coccinellid species were more active during winter months in forest ecosystem and activity were lowest during June, July, April, May and August.

Discussion

The ecosystem plays a vital role in the occurrence of a particular species. It was observed that species abundance increased with increasing vegetation diversity [14]. The study conducted on diversity of coccinellids on crop and forest area indicated that forest area was more diverse compared to crop area [15]. The overall discussion clearly indicated that normally forest area is more diverse than cropped area, which may be due to highly dense cropped, micro climate and less human interventions.

In the present study, we observed highest number of species in agro ecosystem compared to fruit orchards and forest trees with a slight difference of only one species among the different ecosystems studied. This may be due to the continuous and surplus feed availability in the agro ecosystem. The earlier reports on the dominance of *Chilocorus* spp. in forest area and dominance of coccinellids in fruit orchards collaborates with the present findings. Even though, agro ecosystem recorded more number of individuals, forest area possessed the highest number of sub families (i.e., out of 6 sub families, 5 were represented by forest ecosystem except the sub family Epilachinae).

A diversity status of coccinellids in forest as well as agriculture ecosystem by computing Shannon index and evenness values concluded that Coccinellidae was most diverse in crop area than forest ecosystem. The Shannon index values varied in mango orchards indicating species were less diverse but were frequently present [16]. From the ongoing discussion on various aspects of diversity indices, it can be broadly concluded that diversity is always rich, where both species and abundance is maximum. The diversity value tends to decrease, where one or a few species dominate in a community.

Conclusion

Fifteen coccinellid species belonging to 6 sub families were active in the study area of Sardarkrushinagar. Out of 15 species, 9 species were active in agro ecosystem, 8 species in horticulture ecosystem and 7 in forest ecosystem. Out of 15 species recorded, Coccinellinae was represented by 40% of the total species

followed by Chilocorinae and Epilachinae. Among the species, *C. sexmaculatus* represented 41% of the total population and was most active and dominant species prevalent in all the ecosystems under study. Even though, the number of species found in agriculture ecosystem was higher, the taxonomic diversity was more in forest ecosystem as out of 6 sub families, 5 sub families were represented by forest ecosystem indicating its diverse nature.

The maximum species richness of coccinellid was observed during January in agriculture and horticulture ecosystem, whereas in December in forest ecosystem. The species evenness was maximum during July, May and August in agriculture, horticulture and forest ecosystem respectively. The diversity of coccinellids was highest during December in agriculture ecosystem and November in both horticulture and forest ecosystem.

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Author contributions

Shanmugapriya V.* – Acquisition of data, analysis and interpretation of data, drafting of manuscript.

Muralidharan C.M. – Study design and conception, Investigator the research work

Abbreviations:

% - Percentage

°C – Degree Celsius

E – East

i.e., - That is

Log – Logarithm

m– Meter

N – North

Spp. – Species

Viz – Namely

Conflict of Interest: None declared

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