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Research Article

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HOLISTIC SURVEY ON PREDATORY LADYBIRD BEETLE DIVERSITY AT SELECTED REGIONS OF NASHIK DISTRICT (MAHARASHTRA), INDIA

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Abstract: A survey was conducted during January 2016 to December 2017 in four sites of Nashik to study the diversity of the predatory beetles. During the present study, a total of 14 species belonging to 11 genera and 4 subfamilies were recorded from the area studied. Subfamily Chilorinae is represented by 2 species belonging to 2 genera, Subfamily Coccinellinae by 8 species belonging 6 genera, Subfamily Scymninae by 2 species belonging to 2 genera and Subfamily Sticholotidinae by 2 species belonging to the same single genus from the different sites of the study area. The Subfamily Coccinellinae was the most variant and abundant among all the four subfamilies.

Keywords: Biodiversity, Coccinellids, Fauna, Ladybird beetles, Nashik.

INTRODUCTION

Biodiversity is defined as 'the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between the species and in the ecosystems.' The importance of this definition is that it draws attention to the many dimensions of biodiversity. The biodiversity has different levels and values (Verma, 2016). It explicitly recognizes that each and every biota can be characterized by its taxonomic, ecological and genetic diversity and the way these dimensions vary over space and time is a key feature of biodiversity. Thus, only a multidimensional assessment of biodiversity can provide insights into the relationship among changes in biodiversity, changes in ecosystem functioning and ecosystem services. There is a necessity of ecological balance for widespread biodiversity (Verma, 2017a). Agricultural activities cause more prominent changes viz., land and vegetation characteristics on smaller temporal scale and most natural process at a larger spatial scale (Ross and Richards, 1981). Unsustainable agriculture has multiple effects (Verma, 2017b) and disturbs the ecological balance (Verma, 2018a). The

ecological balance is an indispensable need for human survival (Verma, 2018b).

India is very rich in all the aspects of biodiversity and is one of the most significant biodiversity centers of the world. Due to its diversified ecosystems ranging from the snow clad boreal forests in the Himalayas and tropical evergreen forests along with Western and Eastern Ghats, to the dry deserts of Rajasthan, India is considered to be one of the Mega biodiversity countries.

Maharashtra, literally meaning the great state, with its rich biodiversity, is a huge irregular triangle with its base facing the Arabian Sea. Physico-graphically the state may be divided into four natural divisions namely the coastal strip (the Konkan), the Sahyadri or the Western Ghats, the Deccan plateau, and the forests of North Maharashtra. The Northern region of Maharashtra includes Nashik, Dhule, Jalgaon and Nandurbar districts.

Both larvae and adults of insect are predaceous and contribute significantly in natural bio-control of many insect pests. They are important not only because of their significance as bio-control agents, but also due to their diversity and adaptations to a large number of habitats. The degree of their adaptation and efficiency as predator varies with the prey species and the environmental conditions. Coccinellids provide excellent ecosystem service by maintaining ecological balance by keeping the pest densities low and thereby reducing the farmers' dependence on chemical pesticides. Indeed, coccinellids are extremely diverse in their habits and live in almost all the terrestrial habitats.

The Coccinellids, commonly called as lady bird beetles belong to the family Coccinellidae of the order Coleoptera. These are often bright colored with red, orange or yellow elytra frequently spotted black or yellow stripes. Mostly Coccinellids are predaceous and are beneficial from the viewpoint of biological control of pests and feed aphids, scale insects, mites etc. during their larval and adult stages. The species composition under the relationship of many species to habitat can vary in different regions of their distribution and also in different ecosystems.

The coccinellid fauna of the Indian subcontinent is rich and diverse, but poorly studied as compared to those from other zoogeographical regions of the world. As far as the diversity of coccinellid beetles are concerned from the Indian sub-continent, it is studied by Subramaniam (1923) who listed some coccinellid beetles along Estelar 130 with their hosts from southern part of India. The taxonomical description of Scymnus coccivora feeding on neem scales was given by Ayyar (1925). Kapur (1948) reported and described 12 species of Coccinellid beetles and revised the Indian species of Rodolia Mulsant by adding three new species under this genus. Puttarudriah and Channbasavanna (1953) reported 53 species of coccinellid beetles belonging to 23 genera of 8 tribes and 5 subfamilies and 48 species of coccinellids were reported by Usman and Puttarudriah (1955) from Mysore. Kapur (1972) contributed 17 species of ladybird beetles from Goa. Pajni and Singh (1982) recorded 30 species of coccinellid beetles belonging to 18 genera from Chandigarh. Sathe and Bhosale (2001) gave detailed historical account of coccinellids of the world and described 21 species of coccinellid beetles feeding on white flies, aphids and several soft-bodied homopterous pests of agricultural and forest plants from Maharashtra. Kandibane et al., (2005) recorded 7 species of predatory coccinellids in an irrigated rice ecosystem, Madurai, Tamil Nadu. Recently, Joshi and Sharma (2008a and 2008b) reported 31 species of coccinellid beetles with 19 new records from the Haridwar, Uttarakhand, India.

In view of their importance in biological control of crop pests the accurate identification of Coccinellid fauna associated with a particular crop ecosystem and particular region is very useful. Hence, the present investigation was undertaken with an objective to identify the Coccinellid species that are present in Nashik district of Maharashtra, India in different ecosystems.

MATERIALS AND METHODS

On the basis of convenience of location, 15 sites of different habitats were selected for the computation of species diversity in Nashik district. The adult coccinellid beetles were collected from all the sites of Nashik district during January 2016 to December 2017. Sampling of coccinellids was done randomly on monthly intervals. Different methods such as sweep net method, hand picking, baiting and larval searching methods were used for the collection of ladybird beetle to investigate the ladybird beetle fauna in Nashik district. During the study of the area, Sanctuary rules of forest authorities were considered. According to the habitat type, the study area was divided into four sampling sites such as Agriculture (A), Grassland (G), Forest (F), and Human Habitat (H).

Table 1: Sampling and collection sites at Nashik District.

Site	No. of site	Survey site
Agriculture	03	Satana, Deola, Kalwan
Forest	05	Trambak, Igatpuri, Surgana, Dindori, Peth
Grassland	04	Yeola, Chandwad, Nandgaon, Niphad
Human habitat	03	Nashik, Sinner, Malegaon

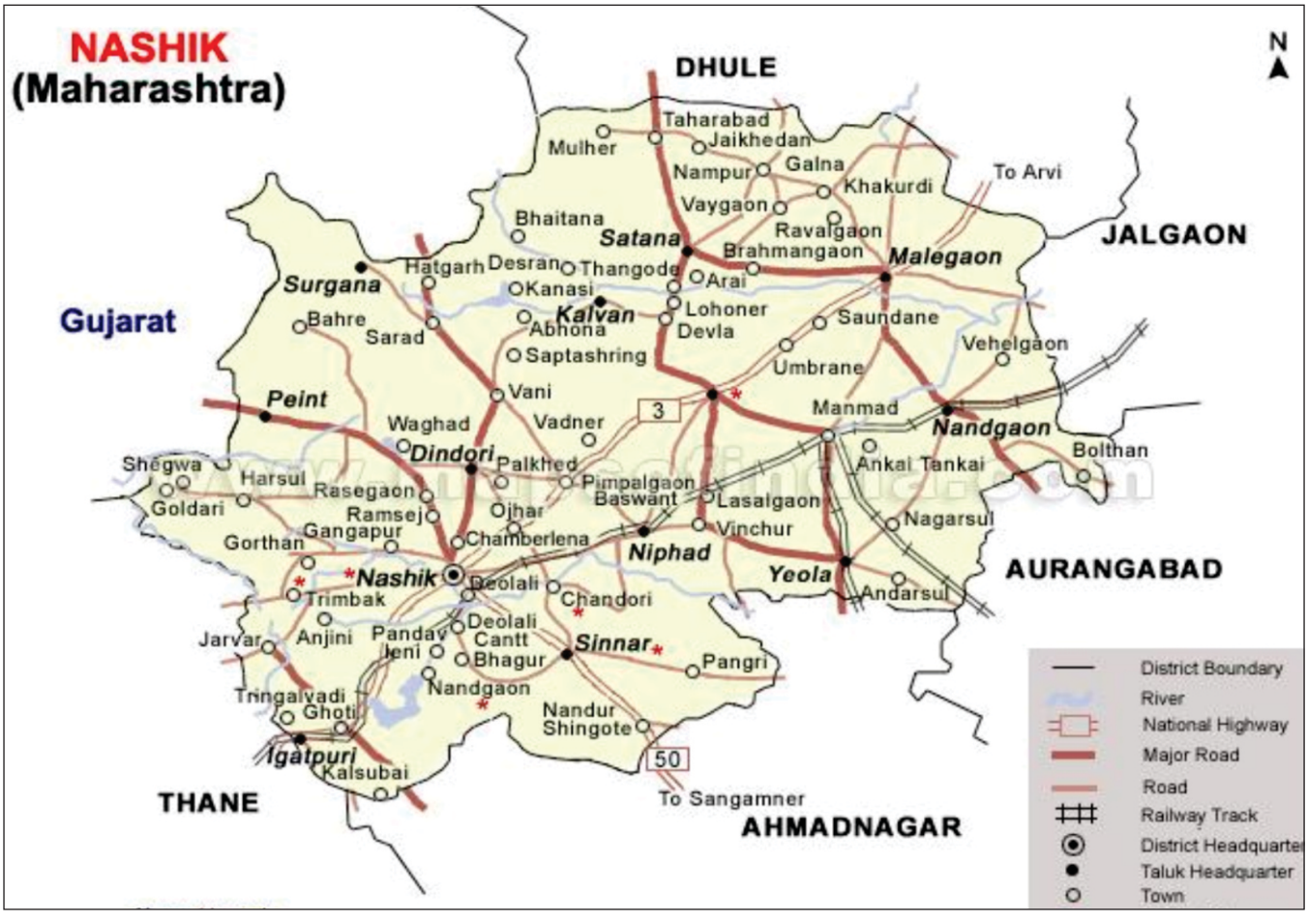


Photo plate I: Source: http://www.nashikdirectory.com/map.html


Photo plate II (a & b) : Study area showing Agriculture field.


Photo plate II. (c & d): Study area showing Agriculture field.


Photo plate III. (a & b) : Grassland field.


Photo plate III (c & d) : Grassland field.


Photo plate IV (a & b) : Forest field.


Photo plate IV (c & d) : Forest field.


Photo plate V. (a & b) : Human habitat.


Photo plate V (c & d) : Human habitat.

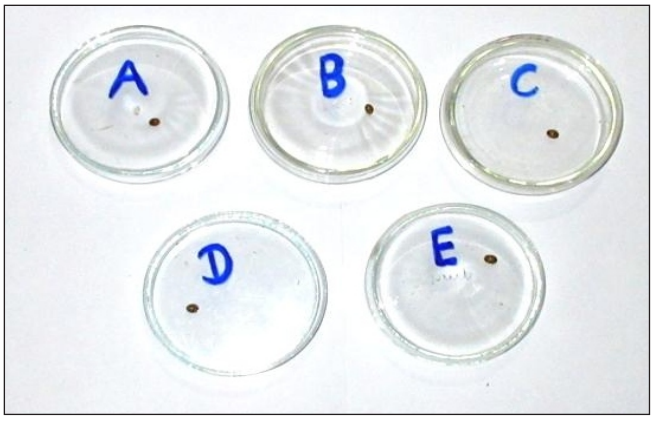


Photo plate VI: Materials for Work.

For collection, preservation and identification of ladybird beetle during present study the standard methodology suggested by Gadakar *et al.*, (1990); Omkar and Bind (1993a, 1993b and 1995); Omkar and Pervez (2000); Poorani (2002) and Desai *et al.*, (2015) was adopted. Hand sweeping net was used to collect the diurnal ladybird beetle species. During field survey, close observation was done during morning and late afternoon when ladybird beetle visited the aphid and whiteflies infected plants.

RESULTS AND DISCUSSION

In the present investigation, 14 Coccinellid species of predatory beetles belonging to 11 genera, under 5 tribes and 4 subfamilies namely Chilocorinae, Coccinellinae, Scymninae and Sticholotidinae were identified from the agricultural (plate II a, b and c, d), grassland (plate III a, b and c, d), forest (plate IV a, b, and c, d) and human habitat (plate V a, b and c, d) of Nashik district from January 2016 to December 2017. The subfamily Coccinellinae was the most varying and abundant subfamily than other three subfamilies. Subfamily Coccinellinae was represented by 8 species belonging to 6 genera from all habitats. Subfamily Sticholotidinae occurred in all the habitats of study area with 2 species belonging to the same single genus, Subfamily Scymninae was reported with 2 species belonging to 2 genera from two sites of the study area. The subfamily Chilorinae is represented by 2 species belonging to 2 different genera from two sites of the study area.

Table 1: Data illustration for taxa recorded from study area.

Sr. No.	Name of Sub- family	Number of Tribe	Number of Tribe	Identification of specimens up to	
				Genus	Species
1.	Chilocorinae	01	02	02	02
2.	Coccinellinae	01	08	06	08
3.	Scymninae	02	02	02	02
4.	Sticholotidinae	01	02	01	02
	Total	05	14	11	14

Table 2: Relative contribution (%) of subfamilies at different habitats of Nashik district during 2016-2017.

Sr. No.	Site / Subfamily	Coccinellinae	Sticholotidinae	Chilocorinae	Scymninae
1	Agriculture	2512 (88.33%)	250 (8.79%)	00 (0.0%)	82 (2.88%)
2	Grassland	3486 (82.23%)	369 (8.70%)	257 (6.06%)	127 (3.0%)
3	Forest	4579 (83.39%)	442 (8.05%)	319 (5.81%)	151 (2.75%)
4	Human habitat	2323 (89.66%)	194 (7.49%)	00 (0.0%)	74 (2.85%)

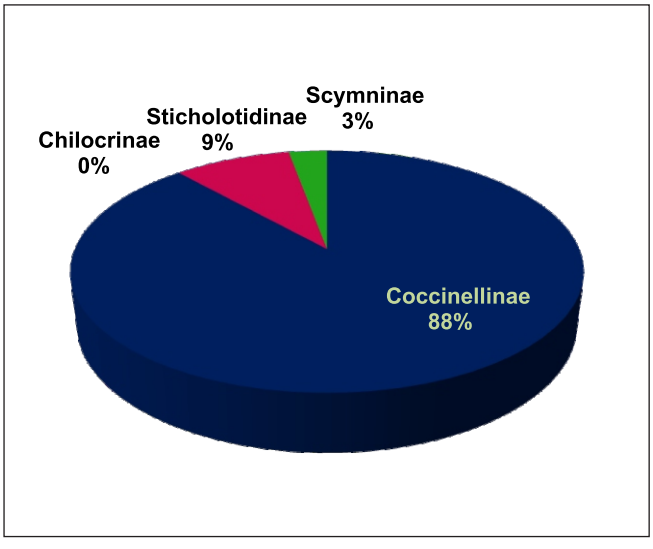


Fig. 1: Relative contribution (%) of subfamilies of agriculture of Nashik during 2016-17.

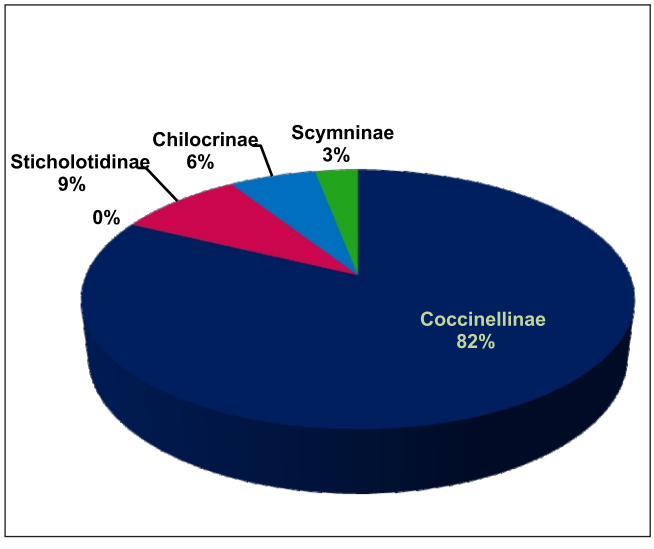


Fig. 2 : Relative contribution (%) of subfamilies of grassland of Nashik during 2016-17.

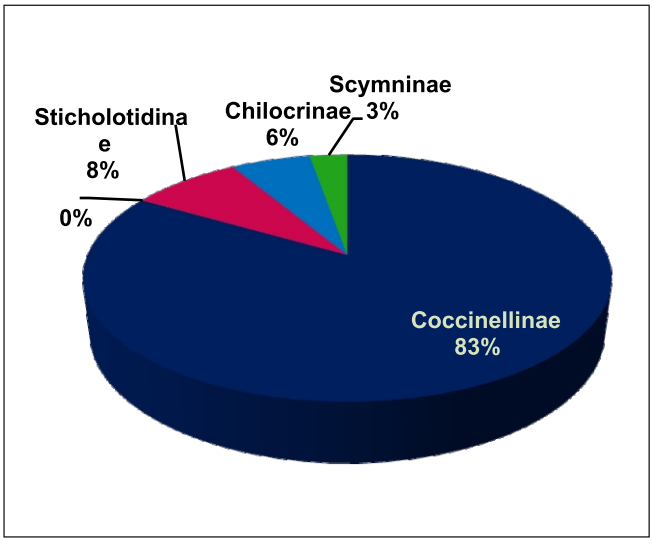


Fig. 3: Relative contribution (%) of subfamilies at forest site of Nashik during 2016-17.

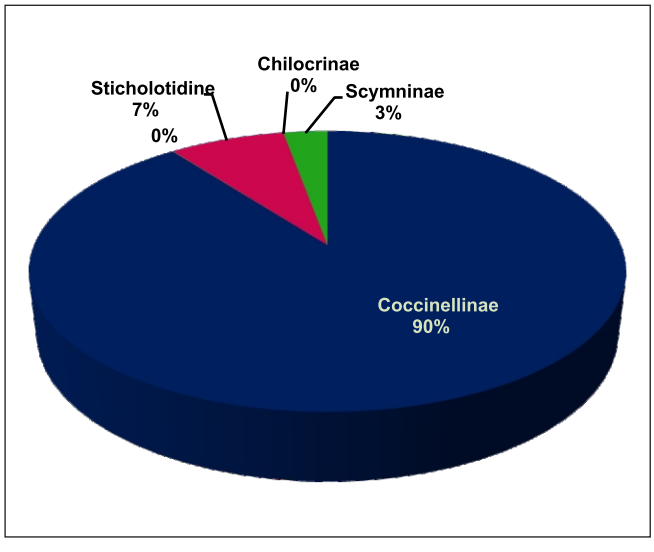
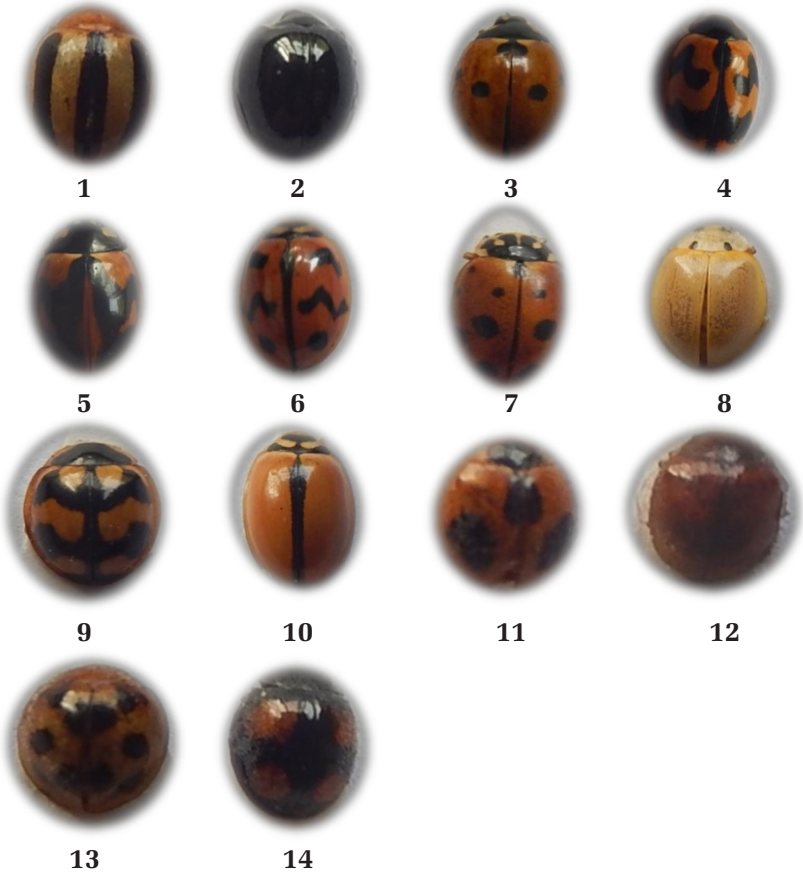


Fig. 4: Relative contribution (%) of subfamilies at Human habital of Nashik during 2016-17.

Table 3: Abundance and distribution of Ladybird beetle from Nashik district during the period of January 2016 to December 2017.

Sr. No.	Taxa	Sites (For 2016-17)				Total	Sites (For 2016-17)				Total
		A	G	F	H		A	G	F	H	
1	*C. septempunctata*	493	662	815	357	2327	638	714	897	479	2728
2	*C. transversalis*	473	623	845	412	2353	589	614	876	522	2601
3	*C. sexmaculata*	358	541	703	367	1969	527	609	815	516	2467
4	*H. variegate*	335	429	601	334	1699	414	557	687	443	2101
5	*H. convergens*	216	396	524	285	1421	328	462	558	346	1694
6	*M. discolor*	319	338	494	256	1407	296	406	509	280	1491
7	*P. dissecta*	157	276	335	146	914	270	326	483	242	1321
8	*I. cincta*	161	221	262	166	810	225	354	408	234	1221
9	*P. horni*	143	184	226	112	665	240	304	356	190	1090
10	*P. flexibilis*	107	185	216	82	590	176	248	296	144	864
11	*B. suturalis*	0	127	171	0	298	0	166	228	0	394
12	*C. nigrita*	0	130	148	0	278	0	152	191	0	343
13	*P. trinotatus*	82	58	78	74	292	196	124	180	153	653
14	*S. latemaculatus*	0	69	73	0	142	0	134	172	0	306
15	Total no. of taxa	11	14	14	11	-	11	14	14	11	-
16	Total	2844	4239	5491	2591	15165	3899	5170	6656	3549	19274



1) *Brumoides suturalis*
2) *Chilocorus nigrita*
3) *Coccinella septempunctata*
4) *Coccinella transversalis*
5) *Cheilomenes sexmaculata*
6) *Hippodamia variegate*
7) *Hippodamia convergens*
8) *Illeis cincta*
9) *Micraspis discolor*
10) *Propylea dissecta*
11) *Pseudaspidimerus trinotatus*
12) *Scymnus latemaculatus*
13) *Pharoscymnus flexibilis*
14) *Pharoscymnus horni*

Photo Plate VI

Table 4: Overall taxonomic composition of ladybird beetle at Nashik district.

Sub Family	Genus Species	A	G	F	H
Chilocorinae	Genus –*Brumoides*				
	Brumoides suturalis	-	+	+	-
	Genus -*Chilocorus*				
	Chilocorus nigrita	-	+	+	-
Coccinellinae	Genus-*Coccinella*				
	Coccinella septempunctata	+	+	+	+
	Coccinella transversalis	+	+	+	+
	Genus-*Cheilomenes*				
	Cheilomenes sexmaculata	+	+	+	+
	Genus-*Hippodamia*				
	Hippodamia variegate,	+	+	+	+
	Hippodamia convergens	+	+	+	+
	Genus- *Micraspis*				
	Micraspis discolor	+	+	+	+
	Genus-*Propylea*				
	Propylea dissecta	+	+	+	+
	Genus-*Illeis*				
	Illeis cincta	+	+	+	+
Sticholotidinae	Genus-*Pharoscymnus*				
	Pharoscymnus flexibilis	+	+	+	+
	Pharoscymnus horni	+	+	+	+
Scymninae	Genus-*Pseudaspidimerus*				
	Pseudaspidimerus trinotatus	+	+	+	+
	Genus- *Scymnus*				
	Scymnus latemaculatus	+	+	+	+

The subfamily Chilocorinae was represented by two species *viz*. *Brumoides suturalis* and *Chilocorus nigrita*, subfamily Sticholotidinae by two species *viz*. *Pharoscymnus flexibilis* and *Pharoscymnus horni* and subfamily Scymninae by two species *viz*. *Pseudaspidimerus trinotatus* and *Scymnus* (*Pullus*) *latemaculatus*. The most diverse and dominating subfamily was *Coccinellinae* represented by eight species *viz*. *Coccinella septempunctata*, *Coccinella transversalis*, *Cheilomenes sexmaculata*, *Hippodamia variegate, Hippodamia convergens, Illeis cincta, Micraspis discolor* and *Propylea dissecta*. Coccinellinae and Scymninae are distributed randomly in Agriculture, Grassland, Forest and Human habitat sites. Whereas two other subfamilies like Chilorinae and Scymninae were found only in two habitats viz Forest and Grassland. Similar pattern was reported during both the years of the study period.

Relative contribution of various subfamilies of ladybird beetle for second year closely resembles the results of first year of the study period. Maximum contribution was of subfamily Coccinellinae (68.84%) followed by Sticholotidinae (21.86%), Scymninae (4.22) and Chilocorinae (5.07%) (tables: 1 to 4 and figure 1 to 4).

Site A-Agriculture:

A total of 2844 and 3899 individuals representing 11 species belonging to 9 genera and 3 Subfamilies were recorded from agriculture site of the study area (plate II a, b, and c, d) during first and second year of the study period respectively.

Subfamily Coccinellinae was represented by 6 genera *Coccinella, Cheilomenes*, *Hippodamia, Micraspis, Illeis, Propylea* whereas 2 genera *Pseudaspidimerus* and *Scymnus* belonging to subfamily Scymninae. The subfamily Sticholotidinae was represented by the single genus *Pharoscymnus* from agricultural site while subfamily Chilocorinae was not represented there.

Site G-Grassland:
A total 4239 and 5170 individual were collected from Grassland site of the study area during 2015-2016 and 2016-2017 respectively. They belong to 14 species, 11 genera, 5 tribes and 4 subfamilies. The subfamily Coccinellinae was represented by genera *Coccinella, Cheilomenes, Hippodamia, Micraspis, Illeis* and *Propylea* whereas genera *Pseudaspidimerus* and *Scymnus* belonging to subfamily Scymninae. The subfamily Chilocorinae was represented by genera *Brumoides* and *Chiocorus* while subfamily Sticholotidinae was represented by genus *Pharoscymnus* from this site (Plate III).

Site F-Forest:
Total 5491 and 6656 individuals were collected from Grassland site of the study area during 2015-2016 and 2016-2017 respectively. They belong to 14 species, 11 genera, 5 tribes and 4 subfamilies. The Subfamily Coccinellinae was represented by genera *Coccinella, Cheilomenes, Hippodamia, Micraspis, Illeis, Propylea* whereas genera *Pseudaspidimerus, Scymnus* belonging to subfamily Scymninae. Subfamily Chilocorinae was represented by genera Brumoides, *Chiocorus*. Subfamily Sticholotidinae was represented by genus *Pharoscymnus* from this site (Plate IV).

Site H-Human habitat:
A total 2591 and 3557 individual representing 11 species belonging to 8 genera and 3 Subfamilies were recorded during first and second year of the study period respectively from this site. The subfamily Coccinellinae was represented by genera *Coccinella, Cheilomenes, Hippodamia, Micraspis, Illeis, Propylea* whereas genus *Pseudaspidimerus* belonging to subfamily Scymninae. The subfamily Sticholotidinae was represented by the single genus *Pharoscymnus* while subfamily Chilocorinae was not represented there (Plate V).

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