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Coccinellid beetles diversity in agro-climatic zones of Bhubaneswar

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Abstract

The current research was conducted to study the abundance and diversity of various species of coccinellid beetles around the agro-climatic zone of Bhubaneswar. It revealed the presence of 10 different species of lady bird beetles viz. *E. vigintioctopunctata*, *B. suturalis*, *C. transversalis*, *C. undecimpunctata*, *C. septempunctata*, *C. sexmaculata*, *H. maindroni*, *A. cardoni*, *S. coccivora* and *P. dissecta*. All total of 1363 numbers of beetles have been collected (few visually counted) from different vegetation including vegetables, crop field, fruit orchards, etc. The abundance of *P. dissecta* species was highest (344) contributing about 25.24% of the total population, followed by *C. septempunctata* (230, 16.87%), and *C. transversalis* (226, 16.58%). But in terms of species diversity, *C. transversalis* was the most diversified species among all followed by *P. dissecta* and *E. vigintioctopunctata*. The collected species of coccinellid were classified into three groups as per their sub-family viz. Epilachninae, Chilocorinae and Coccinellinae. Among them the coccinellinae sub-family included highest numbers of species (6) with maximum abundance in the area having 701 beetles contributing about 51.42% of all coccinellids collected.

Keywords: Coccinellids, Bhubaneswar, lady bird beetles, diversity

Introduction

Generally, beetles belong to the order Coleoptera which is the largest order under class 'Insecta' with about 350,000 known species^[1]. The family Coccinellidae comprises of 5,200 described species worldwide^[2]. Studies have recorded 12 species of coccinellid beetles from Chitral district, Pakistan. Coccinellids are found in many habitats, including those as diverse as cities, fields, gardens, sea coasts and mountains^[3, 4]. Singh and Singh (1990) have reported four new species of genus *Epilachna* Chevrollet from Himachal Pradesh, India^[5]. Omkar and Bind (1996) have reported six species of coccinellids from the Lucknow region of the central U.P.^[5]. Recently, Joshi and Sharma (2008) recently have reported 31 species of coccinellid beetles with 19 new records from district Haridwar, India. In size they range from the minutest (10.25 mm) to the largest (cerambycids 150 mm long)^[6, 7].

Most of the coccinellid beetles are bright and shiny metallic colored insects, and popularly known as lady bird beetles. The beetles have widely diversified habitat with various crop ecosystem. Major of them predate on a variety of soft-bodied insect pests viz., aphids, leafhoppers, scale insects, mealybugs, and mites^[5]. Some are specific in their food choice, while many are polyphagous^[8]. So, it's necessary to maintain their population in environment for better pest control of agricultural crops. The present study was first of its kind to be carried out in the agroclimatic zone of Bhubaneswar. It aimed at examining the host suitability of coccinellid beetles on crop ecosystem and judging their abundance and species diversity through-out the season.

Materials and Methods

The samples were drawn/collected from various agroclimatic zones of Bhubaneswar, covering an area of about 135 Km², lies in 21° 15' North Latitude 85° 15' Longitude south-west of the river Mahanadi in Odisha. Geographically, Bhubaneswar lies in the tropical zone and experiences tropical climate. The three seasons that dominates the city are summer, winter and rainy. The average temperatures waver between 15 °C to 18 °C in the winter. In the summer months mercury rises to a maximum of 40 °C to 45 °C. Monsoons are brought about by the south-east monsoon winds in the month of June.

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Sampling of coccinellids

Sampling of adult coccinellid beetles was conducted at an interval of 30 days from July 2014 to June 2016. The insects were collected by "Sweep sSampling Method", as per Gadakar *et al.* (1990) [10]. Other methods based upon visual encounters, like aspiration and hand picking were also used according to the type of habitats sampled. The habitat included crop land, vegetables, fruit orchard and grasslands, forest ecosystem, etc.

Species identification and diversity analysis

Field collected ladybird beetles were taken to laboratory and transferred into jars containing ethyl acetate soaked cotton. Then the insects were stretched and pinned properly to study the morphological features and identified to species level using identification guides and published literature. The adult specimens of each species were carefully studied for all details under stereoscopic binocular microscope and were separated into different species with the help of available keys [5, 9].

Experimental Findings

Species abundance

After the two consecutive years of study in nearby areas of Bhubaneswar city, 10 different types (species) of coccinellid beetles have been found from different vegetation, viz. food crops, vegetable crops, fruit orchards as well as forest grass land areas. The vegetable crops covered under this investigation included solanaceous crops (brinjal, tomato, chilli), cucurbits (Ridge gourd, bitter gourd and pumpkin), cole crops (cauliflower, cabbage), beans, cow pea, okra, raddish, rice, cashew nut orchard (Table 1). After investigation, ten species of coccinellid beetles were collected and mentioned as follows: *Epilachna vigintioctopunctata*, *Brumoidessuturalis*, *Coccinella transversalis*, *Coccinella undecimpunctata*, *Coccinella septempunctata*, *Cheilomenes sexmaculata*, *Hyperaspis maindroni*, *Aneleis cardoni*, *Scymnus coccivora* and *Propylea dissecta*. The total amount of beetles collected during the study was 1363, from which 348 beetles from solanaceous crops, 259 from rice fields, 192 from cowpea, 137 from cucurbits, 104 from beans, 102 from cole crops, 96 from raddish, 87 from ladies finger, 21 from cashew, and rest were from groundnut, coriander, etc. (Table 2). The result represented the maximum abundance of coccinellid beetles were seen in the case of solanaceous crop followed by rice crop, cow pea, cucurbits, bean, cole crops, raddish, okra and cashew plantation, respectively.

Solanaceous crops found to accommodate the maximum amount of coccinellid beetles on them and among them brinjal crop plays major role in accommodating about 49.43% of beetles, followed by tomato (26.44%) and chilli (24.14%). In case of brinjal, *Coccinella septempunctata* was the major coccinellid group found in large number (52) with an abundance of about 30.23%, whereas *Coccinella transversalis* was the least found lady bird species in brinjal crop ecosystem (Table 1). In case of chilli, *Coccinella septempunctata* population was found larger in number (43) than other species, but in case of tomato crop, *Coccinella transversalis* was the most abundant species. After solanaceous crops the second largest number of coccinellid beetles were observed in a rice field. In case of rice two popularly grown varieties (Pooja and 1014 rice varieties) were taken under study and it was found that 'Pooja' variety attracts larger number of coccinellid beetles (154) than variety '1014' (105). *Propylea dissecta* was the major species that was abundantly found in

rice fields where as other species were very rarely on not at all found on rice crop. Cow pea is found to be the most suitable host for maximum of coccinellid species as except *E. vigintioctopunctata*, all other species were found being associated with cow pea crop. The *C. sexmaculata* and *A. cardoni* were found in large number than other species. In case of cucurbits, the large number of predatory beetles species found on ridge gourd (102) which represent about 74.45% of cucurbits. But the abundance was seen very less in bitter gourd (13.13%) and pumpkin (12.41%). *C. transversalis* was the only species found on cole crops. No other species were seen on cabbage and cauliflower throughout the growing period. Three species of coccinellids were found being associated with bean crop, among which incidence of *C. septempunctata* was greater than others. Raddish crop act as host for two different species of predatory lady bird beetles viz. *Epilachna vigintioctopunctata* and *Propylea dissecta*, among which *E. vigintioctopunctata* found in an exceptionally large number (80) consisting 83.33% of the total population. In case of cashew, coriander, ground nut etc. very less population of coccinellids was recorded.

Forest ecosystem and coccinellid species

In case of forest ecosystem (Chandaka forest reserve, Bhubaneswar), no coccinellid species were found during the sampling period. The reasons might be heavy deforestation, uneven construction patterns of buildings in the periphery of the forest lands, encroachment of forest lands, replacement of indigenous tree species with other non-native trees, increase in the average temperature of the area, felling trees in the forest for agriculture along with overuse of pesticides and fertilizers, and many such factors have played a significant role in disappearance of coccinellid beetles from these forest areas. The second forest zone where the study was conducted (Shikharchandi hill forest area, Bhubaneswar). The same phenomenon was observed with not a single species of coccinellid reported. The forest has been completely destroyed due to urbanization, and only a few hundred trees are left behind with minimal species habitation.

Coccinellid population diversity

The diversity of the lady bird beetles can be judged by analysis of their association with different host crops and according to the sampled area. From the above study, it was clearly concluded that the beetles were diversely present in vegetable ecosystem, but not much diversified in the forest, fruit and pulse ecosystem. The total number of beetle species found was 1363 in number among which, the highest number found was *Propylea dissecta* (344) consisting 25.24% of the total species found. *P. dissecta*, followed by *C. septempunctata* (230), *C. transversalis* (226) and *E. vigintioctopunctata* (202) comprising about 16.87%, 16.58% and 14.82%, respectively (Table 2). The lowest abundance was seen in the case of *H. maindroni* consisting of 1.25% followed by *C. undecimpunctata* (3.01%). Though the abundance of *C. transversalis* is much less than *P. dissecta* but this species was much more diversely present in about all type of crops consisting cow pea, brinjal, tomato, beans, ridge gourd, rice, cauliflower and cabbage.

In relation to host crop, diversity of *P. dissecta* beetle comes later to *C. transversalis* with its association in crops like cashew, brinjal, cow pea, ridge gourd, ladies finger and rice crop (Pooja and 1014). *Epilachna vigintioctopunctata*, *C. septempunctata* and *C. sexmaculata* showed moderate diversity among the ten species of coccinellids. But in case of

C. undecimpunctata, *H. maindroni* and *A. cardoni*, the species were least diverse, each getting attached with only two crops under study (Table 1). In addition to diversity their abundance in crops was also very poor in comparison to other species. In order to study, the diversity of the beetles, they have been identified and categorized according to sub family level. The species found during the collection and bio-diversity study of coccinellid beetles around the Bhubaneswar were arranged into three sub family viz. Epilachninae, Chilocorinae and Coccinellinae, respectively (Table 3). The abundance and

overall diversity of beetles belongs to Coccinellinae, which was found to be more than other two sub families. The abundance of beetles of Coccinellinae sub-family was highest with 701 numbers of species, being 51.42% of all beetles. Sub family Epilachninae, consisted the most diverse species *P. dissecta* with total population of 546 beetles. The least number of beetles found under sub family Chilocorinae (116) contributing only 8.51% to the naturally available beetle population (Table 3).

Table-1 Distribution of coccinellids on various agricultural crops

S. No	Coccinellid species	Crops	Population (n)		Total (N)
			Beetles Collected	Visual Observation	
1	<i>Epilachna vigintioctopunctata</i>	Brinjal	5	23	28
		Beans	2	14	16
		Ridge Gourd	4	39	43
		Pumpkin	5	12	17
		Bitter gourd	1	17	18
2	<i>Brumoides suturalis</i>	Radish	3	77	80
		Brinjal	5	21	26
		Cowpea	3	10	13
		ground nut	2	5	7
		Okra	2	31	33
3	<i>Coccinella transversalis</i>	Chilli	6	14	20
		Cow pea	3	16	19
		Tomato	3	22	25
		Brinjal	1	3	4
		Ridge gourd	8	25	33
		Beans	1	3	4
		Rice (Pooja)	3	36	39
4	<i>Coccinella undecimpunctata</i>	Cauliflower	11	76	87
		Cabbage	2	13	15
5	<i>Coccinella septempunctata</i>	Cow pea	7	21	28
		Tomato	4	9	13
		Cowpea	2	15	17
		Tomato	3	21	24
		Brinjal	9	43	52
		Coriander	8	29	37
6	<i>Cheilomenes sexmaculata</i>	Chilli	11	32	43
		Beans	10	47	57
		Cowpea	8	23	31
		Cashew	1	8	9
		Tomato	2	19	21
7	<i>Hyperaspis maindroni</i>	Brinjal	3	12	15
		Ridge gourd	1	4	5
8	<i>Anegleis cardoni</i>	Cow pea	4	6	10
		Ridge gourd	2	5	7
9	<i>Scymnus coccivora</i>	Brinjal	3	9	12
		Cowpea	2	28	30
		Brinjal	1	8	9
		Cowpea	6	16	22
		Tamato	3	6	9
10	<i>Propylea dissecta</i>	Okra	5	15	20
		Chilli	4	17	21
		Brinjal	11	25	26
		Cashew	3	9	12
		Cow pea	4	18	22
		Ridge gourd	2	12	14
		Ladies finger	5	29	34
Radish	2	14	16		
		Rice (Pooja)	16	99	115
		Rice (1014)	18	87	105

Table 2: Coccinellid species abundance in crop ecosystem

Coccinellid species	Overall Occurrence (n)	%
<i>E. vigintioctopunctata</i>	202	14.82
<i>B. suturalis</i>	99	7.26
<i>C. transversalis</i>	226	16.58
<i>C. undecimpunctata</i>	41	3.01
<i>C. septempunctata</i>	230	16.87
<i>C. sexmaculata</i>	81	5.94
<i>H. maindroni</i>	17	1.25
<i>A. cardoni</i>	42	3.08
<i>S. coccivora</i>	81	5.94
<i>P. dissecta</i>	344	25.24
Total	1363	

Table 3: Coccinellid species diversity as per sub family

Coccinellid species (Sub family)	Total Abundance	%
Epilachninae	546	40.06
<i>Epilachna vigintioctopunctata</i>		
<i>Propylea dissecta</i>		
Chilocorinae	116	8.51
<i>Brumoides suturalis</i>		
<i>Hyperaspis maindroni</i>		
Coccinellinae	701	51.42
<i>Coccinella transversalis</i>		
<i>Coccinella undecimpunctata</i>		
<i>Coccinella septempunctata</i>		
<i>Cheilomenes sexmaculata</i>		
<i>Anegleis cardoni</i>		
<i>Scymnus coccivora</i>	1363	
Total		

Discussion

Coccinellids plays immensely important role in biological control of many soft bodied insects (aphids, mealy bugs, scale insects, whiteflies, thrips) and mite pests growing on cultivated crops, those causes severe crop damage [9]. Due to their diverse food habits and adaptation to wide habitat, coccinellids were referred most successful bio-agents for insect pest management. The introduction of the vedalia ladybird, *Rodolia cardinalis* Mulsant, from Australia into California in 1888 to control cottony cushion scale, *Icerya purchasi*, which threatened the citrus industry, is widely regarded the most successful instances of biological pest control by coccinellids [10]. In Indian subcontinent, a lot of researchers have worked on the biodiversity aspects of coccinellid beetles, such as Subramaniam (1923) listed some coccinellids from South India, Aiyar (1924) added on taxonomical description of *Scymnus coccivora*, Kapur (1948) described 12 new species of coccinellids, and Usman and Puttarudriah (1955) recorded 48 species of predaceous coccinellids from Mysore [11-14].

The coccinellid beetles were regarded as 'Farmers' Friend', as it benefits the farmer in various ways. First of all it helps to reduce the pest incidence from crop by feeding on the soft bodied insects like aphids, leafhoppers, scale insects, mealybugs, mites and others. Reduced pest population needs fewer amounts of chemical pesticides to be applied on the field for pest control which in terms reduce the cost involved in plant protection measures. Reduced use of pesticides reduces the residue hazards in the crop and environment, which not only improves the crop health but also enhances its marketability. A toxicity free environment provides better living condition to farmer and also other naturalbenefiters. Biodiversity studies on predatory ladybird beetles in agro-ecosystems are very scanty in Bhubaneswar area and their

comparative abundance studies between different crops are very limited. In the present study, 10 different species of beetles were found from different crops like brinjal, tomato, chilli, ridge gourd, bitter gourd, pumpkin, cauliflower, cabbage, beans, cow pea, okra, raddish, rice, cashew nut orchard, forest areas, etc. Their abundance and diversity was studied on each crop and result has been interpreted. The population of lady bird beetle greatly depends on the host suitability, i.e. the availability of desired prey on the host [15, 16]. The similar study on coccinellids was conducted by Garcia et al (1997) and recorded 13 species from the crops like alfalfa, corn and wheat and uncultivated habitats [17]. The diversity and distribution of predatory lady bird beetles on five different crops namely wheat, sugarcane, fodder, maize and vegetables and their associated weeds and recorded 12 species including *C. septempunctata* and *C. sexmaculata*. In our research, it was found that brinjal is much preferred by *C. septempunctata*, and *B. suturalis*. According to the study, *B. suturalis* is active throughout the year, except extreme winter conditions. Abundance of *B. suturalis* on brinjal might be due to the availability of its prey, the mealybugs. Cowpea, groundnut and okra crops supported large population of *C. sexmaculata* as *Aphis craccivora* are the best prey for *C. sexmaculata* abundantly found on these crops [17]. Sathe and Bhosale (2001) gave a detailed historical account of coccinellids of the world and described 21 species of coccinellid beetles feeding on aphids and several soft-bodied homopterous pests of agricultural and forest plants from Maharashtra [17, 18]. Kandibane et al. (2005) recorded seven species of predatory coccinellids in an irrigated rice ecosystem, Madurai, Tamil Nadu [19]. Joshi and Sharma (2008) reported 31 species of coccinellid beetles with 19 new records from the Haridwar, Uttarakhand, India [6]. A similar study reported 21 new coccinellid species found in the Western plain zone of Uttar Pradesh. Likewise, nine different species were found in the various crop fields in Gujarat [20, 21].

Conclusion

So, from the above case study on coccinellid beetles distribution and diversity in Bhubaneswar area, it can be concluded that the beetles were well distributed throughout the agricultural crop ecosystem and specifically in vegetable ecosystems. Fruit, forest and grass land ecosystem have comparatively less or no abundance of the lady bird beetles due lack of their hosts. As its presence is most beneficial to the environment in various ways, so the crop ecosystem can be altered or modified to increase their population. Vegetable crops like cow pea, brinjal, okra and beans can be grown along with the main crop like rice, pulses and other planted trees to provide natural control of their pest. Bhubaneswar is a city of hot and humid climate, which can accommodate a large variety of crops and in return the crops can accommodate a diversified group of coccinellids. Broad spectrum study is necessary to investigate and introduce new beneficial species of these beetles to help the farmers' community, as the beetles act as efficient bio-control agents.

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