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Ladybird Beetles (Coccinellidae: Coleoptera) in Southern Telangana: Diversity and Habitat Distribution

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***Abstract*:** This research paper investigates the diversity and distribution patterns of ladybird beetles (Coccinellidae) in agricultural ecosystems of Southern Telangana, with a specific focus on the okra crop. A total of 735 specimens representing 12 species were collected and examined, revealing a diverse assemblage of coccinellids. Among the recorded species, eight belonged to the subfamily Coccinellinae, while the remaining species were distributed across other subfamilies. Notably, the most abundant species in the okra ecosystem was *Illies cincta,* constituting 35.25 % of the total specimens, followed by *Cheilomenes sexmaculata* (15.10 %) and *Propylea dissecta* (12.23 %). The study further elucidates the species richness and abundance of coccinellids across various crops, with ragi and okra hosting the highest number of species. Additionally, diversity indices such as Shannon index (H'), Simpson's index of diversity (1-D), Simpson dominance index (D) and Pielou's evenness index (E) were calculated to assess the diversity of ladybird beetles in the okra ecosystem. The results revealed a high diversity index, indicating a stable ecosystem with complex food webs. These findings underscore the importance of studying coccinellid diversity and distribution in agricultural ecosystems, as they play a crucial role in natural pest control and ecosystem stability. Understanding the dominance patterns of species, species richness and diversity indices can inform effective pest management strategies, ultimately promoting sustainable agriculture.

***Keywords*:** Ladybird beetles, Biodiversity, Habitat distribution, Southern Telangana, Sustainable agriculture

Ladybird beetles, members of the family Coccinellidae within the order Coleoptera, represent a vital component of natural pest control mechanisms in horticultural and agricultural ecosystems (Dixon 2000, Omkar and Pervez 2000). Exhibiting remarkable habitat diversity, these beetles thrive in various environments, including forests, fields, grasslands and gardens. With a global presence, the Coccinellidae family encompasses 490 genera and approximately 6000 described species, classified into six subfamilies: Sticholotidinae, Chilocorinae, Scymninae, Coccidulinae, Coccinellinae and Epilachninae, with recent phylogenetic studies suggesting the addition of a seventh subfamily, Ortaliinae (Slipinski 2007). Within the Indian subcontinent, excluding the Epilachninae subfamily, there exists a rich diversity comprising 400 species (including six subspecies), distributed among 79 genera, 22 tribes and 5 subfamilies (Poorani 2002). Owing to their predatory habits, ladybird beetles play a significant role in regulating populations of various pests such as aphids, leafhoppers, whiteflies, mealybugs and scales, thus contributing to biological pest control strategies. However, certain members of the Epilachninae subfamily exhibit phytophagous behavior, posing a threat to vegetable crops. *Henosepilachna vigintioctopunctata* (Fabricius) and *Epilachna implicata* (Fabricius) are particularly damaging to solanaceous and cucurbitaceous plants, respectively (Megha et al 2015).

The composition of predatory coccinellids varies widely across different agroecosystems. The dependence of any species in a given habitat is mainly determined by the occurrence of prey and abiotic factors. The relationship of many species to a habitat varies in different regions of their distribution and also in different ecosystems. As information on the species composition of coccinellids in agricultural fields of Southern Telangana is not available and considering the importance of these beneficial predators, the present study was conducted to list the species of ladybird beetles with the objective of exploring the beetle fauna, their species composition in okra in particular, along with other existing crop ecosystems in Southern Telangana.

MATERIAL AND METHODS

Ladybird beetle samples were collected from various fields in Southern Telangana, located at Latitude: 17.1231° N and Longitude: 79.2087° E, using net sweeping and handpicking techniques at fortnightly intervals during the *Kharif* season of 2023. Intensive collections were conducted in fields cultivating millets, vegetables, fiber crops, oilseeds and plantation crops. After collection, the beetles were killed using ethyl acetate. The specimens were then thoroughly dried in a hot air oven at 45-50 °C for 4 to 6 hours. The collected specimens were maintained in the Department of Entomology, College of Agriculture, Rajendranagar, for further studies.

During the *Kharif* season of 2023, okra crop was cultivated over an area of 300 square meters using standard agronomic practices (Bhatt et al 2018). Ladybird beetle samples were collected at 15-day intervals over a period of three months, covering an area of one square meter with five replications. The samples were collected into polythene bags and stored in a standard freezer. At the end of the sampling period, the samples were pooled together. Ladybird beetles were subsequently extracted from the samples and identified to the species level, with the recorded species composition documented. Identification of beetle species was conducted based on their morphological characteristics and genitalia.

Species Diversity/Index

Species richness: This term refers to the number of species in a community, directly reflecting the diversity of species in a given area.

Species richness (S) = number of species/genera collected

Species diversity (H'): This computed using the Shannon-Weiner index of diversity (Shannon, 1948):

$$\text{Species diversity (H')} = -\sum^{k} p_i \ln p_i$$

Where p_i represents the proportion of individuals found in species i. For a well-sampled community, p_i can be estimated as n_i/N, where n_i is the number of individuals in species i and N is the total number of individuals in the community. The natural log makes all terms of the summation negative, for which we take the inverse of the sum.

Simpson's dominance index (D): This index measures the probability of two individuals randomly selected from a sample belonging to the same species.

$$D = \sum n_i (n_i - 1) / N (N - 1)$$

Where n_i represents the number of individuals of each species in a sample and N is the total number of individuals of all species in the sample.

Simpson's index of diversity (1 – D): This index represents the probability that two individuals randomly selected from a sample belong to different species was calculated by:

$$1 - D = 1 - [\sum n_i (n_i - 1) / N (N - 1)]$$

Where n_i represents the number of individuals of each species in a sample and N is the total number of individuals of all species in the sample.

Simpson's reciprocal index (1/D): This index provides the number of equally common species that would produce the observed Simpson's index, calculated by:

$$1/D = 1/ \sum n_i (n_i - 1) / N (N - 1)$$

Where n_i represents the number of individuals of each species in a sample and N is the total number of individuals of all species in the sample.

Pielou's evenness index or equitability (E): This index measures diversity along with species richness and is calculated by:

$$E = H'/\ln (S)$$

Where ln(S) represents the natural logarithm of the number of species present. The value of E falls between 0 and 1, with the maximum value achievable in a community where all species are equally abundant.

RESULTS AND DISCUSSION

A total of 735 specimens were examined and 12 species were recorded. Among these, eight species, belonged to the subfamily Coccinellinae and tribe Coccinellini. Two species, belonged to the subfamily Chilocorinae and tribe Chilocorini. One species, to the subfamily Scymninae and tribe Scymnini and another species, *Henosepilachna vigintioctopunctata* (Fabricius) to the subfamily Epilachninae and tribe Epilachnini. Among the millets, seven species were found in brown top millet, five species in maize and six species in ragi. Among the vegetable crops, two species were found in bitter gourd, eight species in okra three species in brinjal and three species in cabbage. Among fiber crops, five species were found in cotton. Among oilseed crops, four species were found in safflower. Among plantation crops, one species (*Illies cincta*) was found in mulberry and one species (*Chilocorus nigrita*) was found in coconut (Table 1).

The diversity of predaceous coccinellids has been extensively documented in various regions across the globe. For instance, Usman and Puttarudriah (1955) reported an impressive total of 48 species of predaceous coccinellids from Mysore State, highlighting the rich diversity of these beneficial insects in the region. Similarly, Sathe and Bhosale (2001) documented 21 predatory coccinellid beetles feeding on aphids and other soft-bodied insects in Maharashtra, emphasizing the ecological importance of coccinellids as natural enemies of agricultural pests. In the northern region of India, Joshi and Sharma (2008) recorded 31 species of coccinellid beetles from Haridwar, indicating a diverse assemblage of these predators in the area. Furthermore, Sharma and Joshi (2010) reported approximately 25 species, while Joshi et al. (2012) documented 23 species of coccinellids from the Dehradun District of Uttarakhand, underscoring the regional variation in species composition. Outside of India, Rahatullah et al (2011) conducted a study in Pakistan and recorded 14 species of ladybird beetles, contributing to the knowledge of coccinellid diversity in the country. Similarly, Biranvand et al (2014) documented 22 species of coccinellids from Iran, providing valuable insights into the distribution of these insects in the region. Present study contributed significantly to our understanding of the species richness and distribution patterns of coccinellid beetles in different ecosystems. There was the significant

variation in coccinellid species richness and composition across different geographical regions.

Species composition and abundance of ladybird beetles in okra crop ecosystem: The species composition and abundance of ladybird beetles were recorded by collecting beetle specimens in the bhendi ecosystem over an area of 300 square meters during the *Kharif* season of 2023. A total of 139 specimens representing eight species, as mentioned above, were captured. These coccinellids were found in the okra crop, feeding on leafhoppers (*Amrasca biguttula*),

Table 1. Distribution of coccinellid beetles across various crop ecosystems

Crop	Coccinellid species	Prey	No. of species
A. Millets			
Brown top millet	*Harmonia octamaculata, Micraspis discolor, Cheilomenes sexmaculata, Coccinella transversalis, Scymnus nubilus, Propylea dissecta, Hippodamia variegata*	*Rhopalosiphum maidis*	7
Maize	*Cheilomenes sexmaculata, Harmonia octamaculata, Micraspis discolor, Scymnus nubilus, Illies cincta*	*Rhopalosiphum maidis,* Mildew (*Illies*)	5
Ragi	*Harmonia octamaculata, Cheilomenes sexmaculata, Hippodamia variegata, Propylea dissecta, Coccinella transversalis, Brumoides suturalis*	*Rhopalosiphum maidis*	6
B. Vegetables crops			
Bitter gourd	*Henosepilachna vigintioctopunctata, Aneglies cardoni*	Phytophagous (*Henosepilachna*), *Bemisia tabaci*	2
Okra	*Brumoides suturalis, Hippodamia variegata, Harmonia octamaculata, Illies cincta, Cheilomenes sexmaculata, Micraspis discolour, Coccinella transversalis, Propylea dissecta*	*Amrasca biguttula, Bemisia tabaci, Myzus persicae*	8
Brinjal	*Cheilomenes sexmaculata, Coccinella trasnversalis, Propylea dissecta*	*Cestius phycitis*	3
Cabbage	*Cheilomenes sexmaculata, Harmonia octamaculata, Scymnus nubilus*	*Brevicoryne brassicae*	3
C. Fibre crop			
Cotton	*Harmonia octamaculata, Cheilomenes sexmaculata, Micraspis discolor, Coccinella transversalis, Hippodamia variegata, Illies cincta, Scymnus nubilus*	*Aphis gossypii, Amrasca biguttula, Bemisia tabaci,* Powdery mildew *(Illies)*	5
D. Oilseed crop			
Safflower	*Cheilomenes sexmaculata, Harmonia octamaculata, Micraspis discolor, Coccinella tranversalis*	*Uroleucon compositae*	4
E. Plantation crops			
Mulberry	*Illies cincta*	Powdery mildew	1
Coconut	*Chilocorus nigrita*	*Aspidiotus destructor*	1

whiteflies (*Bemisia tabaci*) and aphids (*Aphis gossypii*). Additionally, a fungal feeder, *Illies cincta*, was observed feeding on spores of *Erysiphe cichoracearum*, which caused powdery mildew in bhendi. Among all the ladybird beetles, *Illies cincta* (35.25 %) was the most abundant coccinellid, followed by *Cheilomenes sexmaculata* (15.10 %) (Table 2). The high percentage (35.25 %) of occurrence of *I. cincta* might be due to the incidence of powdery mildew during the October to November, as the temperature ranged from 29 °C to 30.6 °C, which was conducive to fungal infection (Rajalakshmi et al., 2016). Similar to the present result, a higher population of *I. cincta* was recorded by Thite et al (2013) during September and October, coinciding with high incidences of powdery mildew on *Dalbergia sissoo* and *Xanthium strumarium.* Among the eight species, *C. sexmaculata* was the most abundant predatory coccinellid beetle in okra ecosystem. Robert et al (2012) in cowpea and those of Rani et al (2013), Shailaja et al (2014), Megha et al (2015), and Rani (2016) reported *C. sexmaculata* as the predominant species.

Chanmamla (2009), recorded 12 species of coccinellids, among which *Coccinella transversalis* (38 %) and *Cheilomenes sexmaculata* (34 %) were the most abundant species, while *Brumoides suturalis* population was very low (1 %). Similarly, Rajan et al (2019) reported that Bhendi harbored the maximum number of coccinellids, including *Coccinella transversalis, Cheilomenes sexmaculata, Hippodamia variegata, Micraspis discolor, Harmonia octomaculata, Illeis cincta, Brumoides suturalis, Stethorus* sp., and *Scymnus coccivora*, with *Coccinella transversalis* and *Cheilomenes sexmaculata* being the two most abundant species. Sharma et al (2017) registered a total of 65 predatory coccinellids associated with different sucking pests and found *Coccinella septumpuntata*, *Hippodamia variegata* and *Cheilomenes sexmaculata* as the most widely distributed coccinellids in all agro-climatic zones of the state. In contrast, Gurung et al (2018) recorded only four coccinellids in okra, namely *Brumoides suturalis, Cheilomenes sexmaculata, Coccinella transversalis* and *Micraspis discolor*, among which *Micraspis discolor* was the most abundant species.

Shah and Ali (2014) conducted a survey on coccinellid biodiversity under pesticide pressure crop ecosystems and reported fewer lady beetle species in pesticide-treated vegetable ecosystems. Similarly, Chakrabothy et al (2014) recorded a higher population of coccinellids in untreated plots (0.47 and 0.50/plant in *Kharif* and *Rabi*, respectively) compared to treated plots (0.18 and 0.28/plant in *Kharif* and *Rabi*, respectively). They also reported a reduction in the population of *C. sexmaculata, C. transversalis, H. octamaculata, M. discolor* and *B. suturalis* from 21.87 % to 60.94 % due to the application of herbicides, insecticides and fertilizers in okra.

Diversity of ladybird beetles in okra crop ecosystem: The present study confirmed the occurrence of 139 specimens of ladybird beetles in bhendi, which belonged to two different subfamilies, Coccinellinae and Chilocorinae (Table 3). Among the two subfamilies, Coccinellinae was more dominant with high species richness comprising seven species belonging to seven genera, followed by the subfamily Chilocorinae with one species belonging to one genus. The diversity indicated a diverse community of coccinellids in the bhendi ecosystem. The high diversity of coccinellids was attributed to a greater number of successful species, a more stable ecosystem, complex food webs and environmental changes less likely to be damaging to the ecosystem as a whole. The structural complexity of habitats has a significant impact on the abundance and diversity of coccinellids (Langellotto and Denno, 2004). Similar results were reported by Ankalgi and Jadesh (2016) with dominance (D) = 0.151, Simpson index of diversity (1-D) = 0.848, Shannon (H) = 2.105, Simpson's reciprocal (1/D) = 6.591 and evenness of 0.745 indicating greater diversity. Rekha et al. (2009) showed more species heterogeneity with richness (3.27), species evenness (1.23) and diversity (0.96) in

Table 2. Species composition and abundance of the coccinellid beetles in okra ecosystem

Subfamily	Species	Abundance	Frequency (%)
Chilocorinae	*Brumoides suturalis*	9	6.47
Coccinellinae	*Hippodamia variegata*	5	3.59
	Harmonia octamaculata	14	10.07
	Illies cincta	49	35.25
	Cheilomenes sexmaculata	21	15.10
	Micraspis discolor	10	7.19
	Coccinella transversalis	14	10.07
	Propylea dissecta	17	12.23

Table 3. Diversity indices of ladybird beetles (Coleoptera: Coccinellidae)

Diversity indices	Values
No. of species (n)	8
No. of specimens (N)	139
Shannon (H')	1.85
Simpson index (D)	0.18
Simpson index of diversity (1-D)	0.82
Pielou's evenness index (E)	0.89

tomato. This highlights the pivotal role of biodiversity conservation efforts in maintaining healthy ecosystems and underscores the importance of continued research to understand and preserve the intricate dynamics of natural habitats.

CONCLUSION

The investigation revealed a diverse assemblage of ladybird beetles across different crop ecosystems, highlighting their adaptability and ecological significance. A total of 12 species of ladybird beetles were reported with *Cheilomenes sexmaculata* (Fabricius) is the most abundant species with 196 specimens followed by *Harmonia octamaculata* (Fabricius) with 131 specimens. In the okra ecosystem alone, a total of 139 specimens representing eight species were recorded, showcasing the prevalence and importance of these predators in controlling common pests such as leafhoppers, whiteflies and aphids. Among the recorded species, *Illies cincta* emerged as the most abundant, followed by *Cheilomenes sexmaculata, Propylea dissecta* and others, with their respective contributions delineated. The dominance of Coccinellinae over Chilocorinae in terms of species richness underscores the varied composition within the family, with each species potentially playing a vital role in maintaining ecological balance. The diversity indices reflected a high diversity of coccinellids, indicative of a stable ecosystem with multiple successful species coexisting synergistically in okra ecosystem. Overall, the study underscores the crucial role of ladybird beetles in integrated pest management and highlights the need for continued research and conservation efforts to safeguard these invaluable allies of agriculture.

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