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Diversity of predatory coccinellids in fruit crops in Madurai and Periyakulam districts of southern Tamil Nadu

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Abstract: Studies were undertaken on the diversity of predatory coccinellids in two locations of horticultural ecosystems comprising citrus, guava, mango, sapota and pomegranate in Madurai and Periyakulam of Madurai and Theni districts, respectively, in Tamil Nadu. Of ten species of predatory coccinellids recorded, the dominant coccinellid species were *Chilocorus nigrita* (F.), *Jauvaria* sp. *Nephus regularis* Sicard and *Nephus* sp. The occurence of *Cheilomenes sexmaculata* (F.), *Scymnus castaneus* Sicard, *Scymnus coccivora* Ayyar and *Pseudaspidimerus trinotatus* Thunberg were low while *Chilocorus circumdatus* (Gyllenhal) was the rare species. Pomegranate in Madurai and citrus and mango in Periyakulam had high species richness. Equitable distribution of species was recorded in mango in Madurai. But more species evenness was recorded in citrus, guava, sapota and pomegranate in Periyakulam. Diversity of coccinellids was high in mango and pomegranate in Madurai while in citrus, guava and sapota in Periyakulam. Simpson's diversity values (for an individual of coccinellid taxa) were high in guava and pomegranate in Madurai, while in citrus, mango and sapota in Periyakulam. This study suggests that the diversity of coccinellid depends on the associated prey insects and more particularly to the locality. Hence, a complete data sheet on the diversity of the coccinellids is warranted on crops in association with prey insects to know the dominant species, which may be conserved or released for efficient biosuppression of pest insects.

Key words: Diversity, coccinellids, citrus, guava, mango, sapota, pomegranate

Introduction

Among the predatory insects, coccinellids, the coleopteran members are an important component of the natural enemy complex of many agricultural and horticultural crop pests such as aphids, mealy bugs, scale insects and mites (Dixon, 2000; Omkar and Pervez, 2000). They are commonly known as lady birds, lady beetles, lady bugs or lady bird beetles belong to the family Coccinellidae, with 330 genera that include about 4,500 species of beetles, distributed across the world (Booth *et al.*, 1990). In India 400 species were recorded under 79 genera of coccinellid fauna (Poorani, 2002). Excellent predatory habit of both adults and grubs of coccinellids, which contribute to the destruction of pest particularly where homopterans are serious, place them as important biocontrol component in pest management programmes. The efficiency and predatory potential to reduce a pest population depend on the innate capacity *of* the individual coccinellid species with reference to an ecological habitate. Hence, diversified species in given ecological zone provide both opportunities and challenges for studying their contribution in

Table 1. Diversity of predatory coccinellids and their associated prey in fruit crops during September 2004-January 2005

Crop	Coccinellid species	Prey
Citrus	*Cheilomenes sexmaculata* (F.)	*Toxoptera citricidus* (Boyor Defonscolombe), *Toxoptera aurantii* (Boyor Defonscolombe)
	Chilocorus nigrata (F.) *Chilocorus circumdatus* (Gyllenhal)	*Pseudococcuus citri* (Ckll.), *Diaphorina citri* (Ashm.) *L. beckii, D. citri*
	Jauravia sp.	*T. citricidus, T. aurantii, D. citri*
	Nephus sp., Nephus regular is (Sicard) *Scymnus castaneus Sicard*	*T. citricidus, T. aurantii, D. citri*
Guava	*Anegleis cardoni* (Weise)	*Chloropulvinaria psidii* (Msk.), *F. virgata, Aleurodicus disperses* (Rusl.), *A. gossypii*
	C. ingrata, Nephus sp., N. regularis *Pseudaspidimerus trinotatus* Thunberg *S.castaneus*	*C. psidii, F. virgata, A. dispersus*
Mango	*A. cardoni, C. nigrata*	*Toxoptera odfnoi* ((Boyor Defonscolombe), *Aleurocanthus mangiferae* Singh *Idioscopus niveosparsus* (Leth.), *Idioscopus clypealis* (Leth.)
	C. sexmaculata	*C. vitis, A mangifera*
	Jauravia sp.	*Amhtodus atkinsoni* (Leth.), *Chionaspis vitis, Drosicha mangiferae*
	Nephus sp., Scymnus coccivora Ayyar	*C. vitis, A mangifera*
Sapota	*Jauravia sp., Nephus sp., P. trinotatus* *S. coccivora*	*T. ricini, F. virgata*
Pomegranate	*Jauravia sp., Nephus sp., P. trinotatus* *S. coccivora*	*Pseudococcus lilacinus* (Ckll.), *Siphoninus punicae* (D.) *F. virgata*
West Indian cherry	*Jauravia sp, Scymnus spp.*	*F. virgata, Maconellicoccus hirsutus (green)*

the buildup of faunal communities. So studies were undertaken to know the diversity of predatory coccinellids in horticultural ecosystems in Periyakulam and Madurai of Tamil Nadu.

Materials and Methods

Field survey for predatory coccinellids

Field surveys were undertaken in two locations; one at the Horticultural College and Research Institute (HC&RI), Periyakulam and Agricultural College and Research Institute (AC&RI), Madurai, respectively, in Theni and Madurai districts of Tamil Nadu during September 2004-January 2005. The occurrence and distribution of predatory coccinellids and their associated prey insects on different host plants *viz.*, citrus, guava, mango, sapota, and pomegranate were recorded, in both the locations, by roving survey once in 15 days on five randomly selected plants.

Estimating the abundance of the coccinellids

Species diversity (H). To study the proportion of each species within the local community, species diversity was computed based on Shannon-Wiener formula, also been called the Shannon index or Shannon-Wiener index (Humphries *et al.,* 1996).

$$H = - \sum_{i=0}^{S} P_i \log_e P_i$$

Where, H is the Shannon-Wiener biodiversity index; P_i is the proportion of each species in the sample (relative abundance); $\log_e P_i$ is the natural log of P_i and S is the number of species in the community.

Species evenness (J). To know the measure of how similar the abundance of different species, species evenness was calculated to estimate the equitability component of diversity (Pielou, 1969).

$$J = H / \log_e S$$

Where, H is the Shannon-Wiener biodiversity index; and S is the number of species in the community.

Species richness (Ma) (Pielou, 1969). To know how the diversity of the population is distributed or organised among the particular species.

$$Ma = S\text{-}l / \log_e N$$

Where, S is the total number of species collected; and N is the total number of individuals in all the species

Simpson's diversity index (Simpson, 1949). This accounts for both richness and proportion (per cent) of each species in the local community. The index has been defined in three different ways.

Simpson's index (D). To know the probability that two randomly selected individuals in the community belong to the same species, Simpson's index was calculated.

$$D = \sum P_i^2$$

Where, Pi is the proportion of each species in the sample (relative abundance)

Simpson's index of diversity (1-D). This measures the probability that two randomly selected individuals in a community belong to different species.

Simpson's reciprocal index (1/D). This estimates the number of equally common species that will produce the observed Simpson's index.

Results and Discussion

Occurrence of predatory coccinellids

The results obtained during September 2004-January 2005 pertaining to the distribution of predatory coccinellids in citrus, guava, mango, sapota and pomegranate ecosystems indicated the prevalence of high number of coccinellid beetles wherever the associated prey population, especially homopterans were more in the field. A total of 10 species of predatory coccinellids were found associated with prey in different fruit crop ecosystems. Altogether, these 10 species of coccinellids fall under 7 genera. The dominant coccinellid species recorded from fruit crops were *Chilocorus nigrita* (F.) *Jauvaria* sp.. *Nephus regular is* Sicard and *Nephus* sp. The occurence of *C. sexmaculata, S. castaneus, S. coccivora* and *Pseudaspidimerus trinoiatus* Thunberg was low, while *Chilocorus circumdatus* Mulsant was the rare species recorded. Coccinellids were reported from all cultivated and uncultivated plants including tree species and were found in abundance wherever the associated prey species also present in abundance. Both the adults and grubs were found feeding on a wide variety of small insect pests infesting crops of economic value. The prey range included homopterans, to a greater extent, *viz.*, aphids (Aphididae), whiteflies (Aleyrodidae), scales (Coccidae), mealybugs (Pseudococcidae), hard scales (Diaspididae), leafhoppers (Cicadellidae), planthoppers (Delphacidae) and a non-insect prey, mite (Tetranychidae: Acarina) (Srivastava *et al.,* 1987; Agarwala *et al.,* 1988; Azia *et al.,* 1989; Omkar and Bind, 1993; 1998; Afroze, 1999; Omkar *et al.,* 1997; 1999). The literature scanning corroborates the present findings that *Nephus regularis* Sicard, *Nephus* sp., *Jauvaria* sp., *A. cardoni, C. nigrita, Pseudaspidimerus trinotatus* Thun. and *S. coccivora* were the predominant taxa (Samways, 1984; Greathead and Greathead, 1992; Booth *et al.,* 1995; Shama Afroze, 2000) while *S. castaneus* and *C. sexmaculata* were present at low abundance (Padmaja, 1995) and *Chilocorus circumdatus* Muls. was recorded wherever diaspine was recorded (Jalali and Singh, 1989).

Comparison of relative abundance and diversity of coccinellids

Citrus. The number of species recorded was five and six from Madurai and Periyakulam, respectively. Periyakulam locality recorded greater richness of species (2.27) as compared to Madurai (1.90). There was also a higher record of species evenness and diversity (1.05 and 0.80) in Periyakulam (Table 2). Species diversity means the distribution and number of species in a given area, habitat, or community under prevailing environmental conditions (Williamson, 1973). It seeks to characterize the diversity in a locality with reference to other localities. Heterogeneity of taxa in a locality is measured by its richness and evenness. Species richness is the most popular approach to evaluate species diversity in a locality and to compare habitats or species assemblages with other locality having different weather conditions (Humphries *et al.,* 1996). In Periyakulam citrus had high species richness with higher coccinellid taxa available in the locality and also the individuals of each species were widely dispersed indicating more equitable relative abundance (Hayek, 1994). Thus such crops, in an indicated locality, with high species richness and more even relative abundance, are a measure of high species diversity (Kikkawa, 1996).

Guava. The coccinellid species recorded from both the localities was six. The higher value of species richness was recorded from Madurai (2.49) while the relative abundance by measurement of species evenness and diversity was recorded from Periyakulam (1.10 and 0.85, respectively) (Table 2).

Table 2. Comparison of abundance, diversity and richness of coccinellids in fruit crops in two locations in two Districts during November 2004 - February 2005

Crop/ location	No.of species (S)	Total no. of individuals in all species	Species evenness (J)*	Species diversity (H)*	Species richness (Ma)*	Simpson's index		
						D*	1-D	1/D
Citrus								
Madurai	5	128	0.941	0.658	1.898	0.238	0.762	4.197
Periyakulam	6	159	1.052	0.798	2.271	0.207	0.793	4.835
Guava								
Madurai	6	102	0.975	0.759	2.489	0.224	0.776	4.464
Periyakulam	6	167	1.097	0.854	2.249	0.227	0.773	4.400
Mango								
Madurai	6	112	0.984	0.766	2.439	0.216	0.784	4.636
Periyakulam	7	148	0.846	0.715	2.764	0.204	0.796	4.891
Sapota								
Madurai	5	94	0.955	0.668	2.027	0.226	0.774	4.422
Periyakulam	5	136	1.113	0.778	1.874	0.219	0.781	4.569
Pomegranate								
Madurai	5	118	0.949	0.664	1.930	0.205	0.795	4.872
Periyakulam	4	65	0.994	0.599	1.654	0.251	0.749	3.990

*Values in the columns are indices

Mango. Periyakulam locality recorded with seven species, while Madurai had six. The species richness was higher in Periyakulam (2.76) while high representation of species in terms of evenness and diversity was recorded from Madurai (0.98 and 0.77, respectively) (Table 2).

Sapota. The number of species recorded was five each at both the localities. Madurai showed greater value of species richness (2.03), while Periyakulam locality showed higher values of species evenness and diversity recording 1.11 and 0.78, respectively (Table 2).

Pomegranate. The number of species recorded from Madurai and Periyakulam were five and four, respectively. The higher species richness and diversity were recorded from Madurai (1.93 and 0.67). The abundance of an individual species was higher at Madurai with the value of 0.994 (Table 2). This relative measure of diversity is used for comparisons among different localities, under same sample size, to evaluate its heterogeneity (Magurran, 1988). Recently, Kandibane (2003) and Kandibane *et al.*, (2005) reported that of a total of seven taxa recorded in rice ecosystem, all the seven were present in partially weeded rice, while

weeded rice had only five. They further stated that more the diversity of host plants (supporting sources in an ecosystem) more is the herbivore *vis-a-vis* predatory insects, which lead to a perfect biotic balance.

Simpson's diversity index

The data computed by the Simpson's diversity index revealed that the probability value (1-D) was highest in Madurai locality for crops like guava (0.78) and pomegranate (0.80), while the crops like citrus (0.79), mango (0.80) and sapota (0.78) showed higher probability value in Periyakulam (Table 2). Simpson's diversity index is a measure for both richness and proportion of each species in a given locality. Thus, indicating the probability of two randomly selected individuals belonging to different taxa. The present study indicated that the probability was high in Madurai for crops *viz.*, guava and pomegranate, while in Periyakulam for citrus, mango and sapota. This is in accordance with the findings of Hayek (1994) that the higher probability for two randomly selected individuals in a locality, for such crops, being less equitable and the selected individuals belong to different taxa. The higher index values for such crops in a locality were due to the vegetation found surrounding the field, which might also provide prey insects and other alternate resources.

Conclusion

The present study suggests that the dominance of coccinellid species in a locality depends on host plants, prey insects and local habitate. Hence, an explicit inventory is warranted on host plants and prey insects more particularly the diversity data with reference to ecological habitate to know the dominant coccinellid species, which will help to prepare for its (their) conservation or augmentation in the successful biocontrol programmes.

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Reference

Afroze, S. (1999). Preferential predation by *Anegleis cardoni* (Weise) (Coccinellidae: Coleoptera) on some aphid species. *Journal of Aphidology*, **13 :** 95-97.

Agarwala, B.K., Das, S. and Sen Chowdhuri, M. (1988). Biology and food relations of *Micraspis discolor* (F.), an aphidophagous coccinellid in India. *Journal of Aphidology*, **2 :** 7-17.

Aziz, S.A., Hyder, S.N. and Ali, M.H. (1969). Studies on the host preference of *Coccinella septempunctata* Linn. *Indian Journal of Entomology*. **31:** 350-353.

Booth, R.G., Cox, M.L. and Madge, R.B. (1990). *HE guides to insects of importance to maize. No. 3, Coleoptera* C.A.B. International, London

Dixon, A.F.G. (2000). *Insect predator-prey dynamics, ladybird beetles and biological control.* Cambridge Univesity Press, London

Great Head, *DJ.* and Great Head, A.H. (1992). *Biocontrol News and Information,* **13 :** 61-68.

Hayek, L.C. (1994). Analysis of amphibian biodiversity data, In: *Measuring and Monitoring Biological Diversity, Standard Methods for Amphibian* Eds. Heyer, W.R. Dannely, M.A., Me Diarwid, R.W., Hayek, L.C. and Foster M.S., South Indian Substitution Press, Washington, pp. 207-270.

Humphries, C. J., Williams, P.H. and Vane-Wright, R.K. (1996). Measuring biodiversity value for conservation. *Annual Review of Ecology and Systematics,* **26 :** 93-111.

Kandibane, M. (2003). Biodiversity of arthropods in irrigated rice ecosystem. Ph. D. Thesis, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, 256pp.

Kandibane, M, Raguraman, S. and Mahadevan N.R. (2005). Taxonomic similarity and relative abundance of predatory coccinellids in an irrigated rice ecosystem of Tamil Nadu. In *Abstract Proceedings of VII National Symposium on Indian Entomology: Productivity & Health*, October 2-4, 2005. The Utter Pradesh Zological Scoiety, Muzaffernagar,pp 63.

Kikkawa, J. (1996). Complexity, diversity and stability. In *Community Ecology: Pattern and Process* Eds., Kikkawa. J. and. Anderson, D.J., Blackwell Scientific Publications, Melbourne, 41-65 pp.

Magurran, A.E. (1988). *Ecological diversity and its measurement.* Princeton University Press, Princeton.

Omkar and Bind, R. B. (1993). Prey preference of a ladybird beetle, *Cheilomenes (=Menochilus) sexmaculata* (Fab.). *Journal of Aphidology*, **12 :** 63-66.

Omkar and Bind, R.B. (1998). Records of aphids-natural enemies complex of Uttar Pradesh. II: The coccinellids. *Journal of Advanced Zoology*, **14 :** 96-99.

Omkar and Pervez, A. (2000). Biodiversity of predaceous coccinellids (Coleoptera: Coceineliidae) in India: a review. *Journal of Aphidology*, **14 :** 41-67.

Omkar, Srivastava, S. and James, B.E. (1997). Prey preference of a lady beetle, *Coccinella septempunctata* Linnaeus (Coleoptera: *Coceineliidae). Journal of Advanced Zoology*, **15 :** 96-97.

Omkar, James, B.E. and Srivastava, S. (1999). Prey preference of a lady beetle, *Coccinella transversalis* Fabricius (Coleptera: Coceineliidae). *Advances in Biosystematics*, **18:** 117-122.

Padmaja, C.H., Ramesh Babu, T., Reddy, D.D.R. and Sriramulu, N. (1995): Biology and predation potential of *Scymnus coccivora* Ayyar (Coleoptera: Coceineliidae) on mealybugs. *Journal of Entomological Research*, **19 :** 79-81.

Pielou, E.C. (1969). *An introduction of mathematical ecology.* Wiley Interscience, New York, USA.

Poorani, J. (2002). An annotated checklist of the Coceinellidae (Coleoptera) (excluding epilachninae) of the Indian Subregion. *Oriental Insects*, **36 :** 307-383.

Samways, M.J. (1984). Biology and economic value of the scale predator *Chilocorus nigritus* (F.) (Coceineliidae). *Biocontrol News and Information*, **5 :** 91-105.

Shama, A. (2000). Bioecology of the coccinellid *Anegleis cardoni* (Weise) (Coleoptera: Coccinellidae), an important predator of aphids, coccids and pseudococcids. *Journal of Entomological Research*, **24 :** 55-62.

Simpson, S.J. (1949). The measurement of species diversity. *Annual Review of Ecology and Systematics*, **5 :** 285-307.

Srivastava, A.S., Katiyar, R.R. Upadhya, K.D. and Singh, S.V. (1987). Studies on the food preference of *Coccinella repanda* Tunberg (Coleoptera: Coccinellidae), *Indian Journal of Entomology*, **49 :** 551-552.

Williamson, M. (1973). Species diversity in ecological communities. In *The mathematical theory of the dynamics of biological populations*, Eds., Bartlett M.S. and Horns R.W., Academic press, London, pp 325-336.