Diversity and Abundance of Ground Beetles (Carabidae: Coleoptera) in Eco-Friendly Home Gardens in Comparison with Conventional Home Gardens in Southern Dry Zone of Sri Lanka

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Abstract

Insect diversity plays an important role in agro-ecosystem in relation to stability and productivity; therefore, conservation of biodiversity is important for long-term viability of agro-ecosystems. Biodiversity in farm lands is threaten by some practices carried out by the growers such as extensive application of non-selective weedicides, misuse of insecticides, extensive ploughing, burning of crop waste etc. In order to conserve the biodiversity, it is necessary to promote the eco friendly practices such as low or no use of pesticides, organic manure application, enhance plant diversity, and soil and water conservation. Biodiversity improvement through these practices has been recorded elsewhere but local data are scant. Hence, the objective of this study was to assess the biodiversity; diversity of carabid beetles in multiregional homegardens that were managed as eco-friendly, nutritional home gardens in comparison with conventionally managed home gardens. Field study was carried out during 2009-2012 in selected three villages: Kumaragama, Katuwanayaya and Elisonkanda in Hambantota district. Carabid beetles were sampled from four conventional and four eco-friendly nutritional home gardens in each village using pitfall traps. Of the insects collected, 164 carabids that were belonging to five genera: *Bembidion, Cicindela, Harpalus, Pheropsophus,* and *Scarites* were identified. *Pheropsophus* sp. were more abundant (36.5%) followed by *Scarites* spp. (9.7%). Carabid abundance was significantly higher in eco-friendly homegardens (X^2 =72.8 df=1 $p<0.001$) than in conventional home gardens. Carabid species diversity also followed the same trend. There was a significant variation among the sampling locations: Katuwanayaya, Elisonkanda and Kumaragama in terms of total carabid number (X^2 =16.9; df=2; $p<0.001$). The study revealed higher diversity and abundance of carabids in eco-friendly home gardens in compared to the conventional home gardens.

Key words: Carabid diversity, Home gardens, Ecological farming, Dryzone, Sri Lanka

Introduction

Insect diversity plays an important role in agro-ecosystem especially in relation to stability and productivity (Schoowalter, 2006). Therefore, conservation of diversity is important for long-term sustainability of the agro-ecosystem (Minor, 2005). Biodiversity in farm lands is threaten by some practices carried out by the growers such as extensive application of non-selective weedicides and insecticides, extensive ploughing, burning of crop waste etc. (Altieri *et al.*, 2005). In addition, insecticide application is associated with several environmental and health issues. Misuse of pesticides could enhance resistance development in insects, pest resurgence and secondary pest outbreaks, demanding frequent application of insecticides. This leads to destruction of natural enemies living in the ecosystems. Moreover, pesticide residues on agriculture produce creates health problems through chronic and acute poisoning. Hence, insect pest management in agro-ecosystem with low or no use of insecticide together with strategies that enhance plant diversity, soil and water conservation and promotion of using organic manure is a timely need to manage these issues. Having this overall objective, a nongovernmental organization transformed several farmlands (home gardens) in the southern dry zone of Sri Lanka, into nutritional home gardens incorporating eco-friendly practices as described by Weerakkody *et al.* (2011). It was expected that the insect diversity would be enhanced with time together with plant, animal and microbial diversity.

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Carabid beetles (Coleoptera: Carabidae) are incredibly diverse group of insects with over 40,000 species worldwide. In Sri Lanka, this group is represented by 525 species that belongs to 140 genera (Erwin, 1984). Members of this family are considered to be mostly opportunistic feeders that consume a variety of foods, but the majority has been observed as predators. These predators consume a wide assortment of soil dwelling insects, including caterpillars, wireworms, maggots, ants, aphids, and slugs. Therefore, carabid beetles play an important role in agro-ecosystems, controlling a variety of pest organisms.

The objective of this study was to assess the diversity of carabid beetles in multiregional homegardens that were managed as eco-friendly, nutritional home gardens in comparison with conventionally managed home gardens.

Materials and Methods

Field study was carried out during 2009-2012 in selected four villages: Kumaragama, Katuwanayaya and Elisonkanda in Hambantota district. In each village, eight farmer fields were selected and four of those were maintained as eco-friendly nutritional home gardens (Weerakkody *et al.,* 2011) whereas, other four fields were maintained as conventional home gardens without project interventions. Pest management in nutritional home gardens was being done using nonchemical methods. The management strategies includes, frequent crop examination followed by manual removal of infestation, wood ash dusting, soap water spraying, application of herbal decoction *"puncha kavuya"*, addition of biochar, maintain of flowering plants on field boarders and mulching of soil. Cowpea (*Vigna unguiculata* (L.) was cultivated in a section of each home garden. Size of the cowpea plot ranged from 3 perch to 10 perch depending on the size of the home gardens (0.2-0.5 ha). Cowpea fields were sampled to assess the ground dwelling insect populations using pitfall traps. Pitfall traps were installed using 200 ml plastic cups. Those were buried in a way, the rim of the cup (5 cm) was levelled with soil surface facilitating insects to walk into the trap. Cups were half filled with concentrated salt solution to avoid the decaying of trap content and covered with a rain guard to avoid rain water collection and to keep the predators away. The traps were run for three consecutive days in the field and emptied. There were four traps in each field, and all the traps were installed in the same day and emptied, three days after installation. The trap content was strained using a tea strainer and cleaned with water after removing other debris. The insects were stored in 70% ethanol in plastic vials and labelled with collection data. The insects gathered were then examined under dissecting microscope (x10 - x70) in Entomology laboratory of Dept. of Agricultural Biology, Faculty of Agriculture, University of Peradeniya and sorted into different taxonomic groups. The carabid beetles were identified upto genus level using available taxonomic keys (Erwin, 1984; Andrews, 1928), and sketches and photographs available online. The data were analysed using loglinear analysis in SYSTAT ver 13. Shannon-Weaver diversity index (H') was calculated to compare the species diversity in tested locations.

Results and Discussion

Of the insects collected in pitfall traps, 164 beetles (ground beetles) belonging to five genera: *Bembidion, Cicindela, Harpalus, Pheropsophus,* and *Scarites* of the Family Carabidae were identified. There were 71 beetles with similar morphology belonging to Family Carabidae, but the genus was not determined as per the available resources. *Pheropsophus* sp. were more abundant (36.5%) followed by *Scarites* spp. (9.7%). Abundance of other genera is less than 5%. The undermined genus was the most abundant which represent 43.3% (Table 1).

Table 1. Carabid beetle species and their abundance in two agricultural ecosystems in Southern Dryzone of Sri Lanka.

Carabidae genus	Total no. of insects	Cultivation system	
		Conventional (%)	Eco-friendly (%)
Bembidion sp.	5 (3.0 %)	0.61	2.44
Cicindela sp.	6 (3.7%)	0.61	3.05
Harpalus sp.	6 (3.65%)	2.44	1.22
Pheropsophus sp.	60 (36.58%)	15.24	21.34
Scarites sp.	16 (9.75%)	3.05	6.71
Unidentified sp.	71 (43.29%)	4.88	38.41

The species diversity was high in eco-friendly home gardens in Katuwanayaya and Elisonkanda villages (Table 2). This indicates that the below ground environment of those fields are very favourable for the inhabiting insects. Conversely, low H' values (Table 2) in conventional home gardens reflects that the soil is much more degraded due to cultivation practices resulting less suitable habitats for carabids.

Table 2. Shannon-Weaver diversity index (H') of carabid beetles in study areas

Location	Cultivation system	
	Conventional	Eco-friendly
Katuwanayaya	0.41	1.04
Elisonkanda	0.99	1.12
Kumaragama	1.17	0.62

There was a significant variation between the two field types: conventionally managed field (Conventional) and nutritional home garden, managed using eco-friendly practices (Eco-friendly) in terms of total number of carabid beetles (X^2 =72.8; df=1; p<0.001).

Eco-friendly home garden had 75% of total beetles. This suggests that the practices carried out in eco-friendly home gardens which includes mulching, maintaining flowering plants in field boarders, and no application of synthetic agrochemicals had influenced positively for carabid abundance. Carabids are generalist predators that play a major role in natural suppression of pest populations. They feed on adults and immature insects of suitable size for them. High abundance of carabid beetles in organically grown fields compared to conventional fields had been well established (Dritschilo *et al.*, 1980), but not with local data.

There was a significant variation among the sampling locations: Katuwanayaya, Elisonkanda and Kumaragama in terms of total carabid number (X^2 =16.9; df=2; p<0.001). However, the interaction between sampling locations and the field type was not significant; indicating that the general trend of having high carabid abundance in eco-friendly homegardens remains the same across the sampling locations. Hence, it can be suggested that the practices followed through project intervention were influencing to conserve the carabid abundance irrespective to the geographical location. In addition, Carabid number significantly varied among the home gardens (farmer fields) in a given management practice: conventional or eco-friendly.

Further, the interaction between home garden and field type was also significant (X^2 =24.9 df=3 p<0.001). Further, the interaction among field type (conventional or eco-friendly) x homegarden (farmer) x sampling locations (village) was also significant (X^2 = 34.7; df=6; p<0.001). This reflects that the level of implementation of suggested practices, land size, crop diversity in the home garden were influencing the carabid abundance.

This variation may be associated with the dedication of the farmer for the project work, enthusiasm on ecological farming, awareness on hazards associated with synthetic insecticides, active participation on project meetings etc.

With these results, it can be concluded that there is a general trend of promoting carabid beetles in eco-friendly home gardens as an effect of practices that were carried out in eco-friendly home gardens. This enriched diversity of carabid fauna is useful in ecologically based pest management. However, the data considered here is not sufficient to identify which practices are influential in promoting carabid beetles.

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