

Original Research Article

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Diversity and Abundance of Chrysopids in Different Ecosystems

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ABSTRACT

The present study was restricted to collection of insects belonging to the order Neuroptera and totally 5632 arthropods were collected. In total two families of Neuroptera were collected. More number of individuals fell under the family Chrysopidae (2995) followed by Hemerobidae (907). Four different sp. of chrysopids viz., *C. zastrowi silemni*, *M. boninensis*, *M. astur* and *Hemerobius sp.* were recorded from all the six eco systems. More numbers of chrysopids viz., *C. zastrowi silemni*, *M. boninensis*, *M. astur* and *Hemerobius sp.* were recorded in November and December (2013), whereas less numbers were recorded in May and in June (2013) months in rose ecosystem. More numbers of chrysopids were recorded in November and December (2013) followed by November (2012), whereas less numbers were recorded in May, June and in July (2013) months respectively in tapioca ecosystem. More number of chrysopids were recorded from October to December (2013) followed by November and in December (2012) whereas less numbers were recorded in June (2013) in papaya ecosystem. Chrysopids were relatively more in October and in November (2013) followed by November and December (2012) and relatively less numbers were recorded in May and June months (2013) respectively in mango ecosystem. More number of chrysopids were recorded from October to December (2012) followed by September to December (2013) whereas less numbers were recorded in May and June months (2013) in sapota ecosystem. Chrysopids were relatively more in October to December (2013) and in November to December (2012) and relatively less numbers were recorded in May and June months (2013) respectively in guava ecosystem.

Keywords

Mallada boninensis,
Chrysoperla,
Ecosystems, Rose,
Tapioca, Papaya,
Guava, Mango and
Sapota

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Introduction

Among complex network of bioagents, Chrysopids or green lacewings are known to be the most effective predators, they belongs to order 'Neuroptera'. This order consists of a group of insects with soft bodies, biting mouthparts and two pairs of very similar membranous wings, which are usually held

roof-like along the abdomen at rest. Their agricultural importance lies in their carnivorous habits. Green lacewings are considered to be one of the most effective generalist predators used in biological control. The larvae feed on pest aphids, scales, caterpillars, spider mites etc. infesting a variety of plants (McEwen *et al.*, 2001). Adults are generally not predatory and feed on

nectar, pollen or honeydew, while a few of them are predatory (Coppel and Mertins, 1977). Studies have demonstrated lacewings as effective predators of aphids, leaf miners, mites, thrips, whiteflies, eggs of leafhoppers, small caterpillars, citrus psylla, citrus black fly, scales and mealybugs etc. In recent years use of green lacewing species have been recommended for the IPM programmes (Nehare *et al.*, 2004). Keeping in view the importance and use of chrysopid predators in different ecosystems diversity and abundance of chrysopids were recorded in different ecosystems.

Materials and Methods

Intensive survey was undertaken during September 2012 to December 13 in major horticultural ecosystems of rose, tapioca, papaya, mango, sapota, and guava in Salem, Coimbatore, Tirupur and Erode districts of Tamil Nadu with special reference to Neuroptera to calculate alpha diversity indices.

Alpha diversity indices

Alpha diversity indices are measures of species diversity (or richness) of a local community or habitat.

Species richness indices

Species number (Magurran, 1987)

This presents the total number of species in each sample.

Shannon's diversity index (Batten, 1976)

This represents the Shannon – Weiner (also called as Weaver) diversity index and is defined as:

$$H' = - \sum_{i=1}^s P_i \ln P_i$$

$$i = 1$$

where,

H' is the species diversity index

s is the number of species, and

P_i = the proportion of individuals of each species belonging to the i^{th} species of the total number of individuals.

This index is calculated using the natural logarithm. The higher the number, the higher is the species diversity.

a) Fishers alpha (Fishers *et al.*, 1943)

This presents the alpha log series parameter for each sample. This is a parametric index of diversity that assumes the abundance of species and follows the log series distribution.

$$Ax, ax^2/2, ax^3/3 \dots ax^n/n$$

where, Ax = the number of species to have one individual

$ax^2/2, ax^3/3 \dots ax^n/n$ = those with 2 individuals and so on.

Each term gives the number of species predicted to have 1, 2, 3... n individuals in the sample. This is a useful index, which has been widely used.

Margalef's D (Clifford and Stephenson, 1975)

Margalef's D has been a favourite index for many years. It is calculated using the following formula.

$$D_{Mg} = (S-1) / \ln N$$

where,

S = the number of species recorded

N = the total number of individuals summed over all in S species

Brillouin diversity index (Magurran, 1987)

The Brillouin index (H), is calculated using:

$$H = \ln N! / \sum_{i=1}^S \ln n_i! / N$$

where,

N = the total number of individuals in the sample

n_i = total number of individuals belonging to the i^{th} species and the species number

Species dominance indices

Simpson's diversity index (Simpson, 1949)

Simpson's index (D) describes the probability that a second individual drawn from the population should be of the same species as the first. It is given by the following formula.

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

where,

N = the total number of organisms of all species and

n = the total number of organisms of a particular species

From which, Simpson's Diversity Index, $1 - D$, is found. So, the larger its value, greater is the diversity.

Berger Parker diversity index (Berger and Parker, 1970; May, 1975)

Berger Parker index is a simple measure of species dominance. The index expresses the proportional importance of the most abundant species.

$$d = N_{\max}/N$$

where,

N_{\max} is the number of individuals in the most abundant species and

N is the total number of individuals in the sample

This sample index was considered by May (1975) to be of the best indices. It is a simple measure of numerical importance of the most abundant species.

McIntosh index (McIntosh, 1967)

This index is calculated using the following formula proposed by McIntosh (1967).

$$D = N-U/N - \sqrt{(N)}$$

$$U = \sqrt{(\sum n_i^2)}$$

where,

N is the total number of individuals in the sample and

U is given by the expression

$$U = \sqrt{\sum [n(i)]},$$

where,

n (i) is the number of individuals in the i^{th} species and the summation is undertaken over all the species.

Evenness indices

Evenness (E) is a measure of the similarity between the abundance of different species, in a community. When evenness is close to the value one, it indicates that each species consists of the same number of individuals or that most of the individuals belong to one or a few species.

Equitability J (Magurran, 1987)

Equitability (J) or evenness refers to the pattern of distribution of the individuals between the species. This measure of equitability compares the observed Shannon-Weiner index against that distribution of individuals between the observed species which would maximize diversity. If H is the observed Shannon-Weiner index, the

maximum value this could take is $\log(S)$, where S is the total number of the species in the habitat. It is indicated as follows.

Record of predators

During the survey other predators were also recorded in the field and identified by the scientist specialised in those fields or with the help of available reference collections.

Results and Discussion

The present investigation yielded 5632 individuals of arthropods belonging to the class insecta (most common) followed by Arachnida, Diplopoda and Chilopoda (Table 1). In current study, alpha diversity was estimated based on species number, Shannon-Weiner index, Fisher alpha index, Margalef D index and Brillouin index, while dominance was based on Simpson, Berger-Parker and McIntosh indices. In these instances, the analyses were subjected to three levels of classification *viz.*, based on family, genus and species. Species richness and diversity are commonly used for conservation purposes and to assess ecosystem fitness (Norton, 1986; Probst and Weinrich, 1993). However, Cardoso *et al.*, (2004) confirmed the fact that inventories at species level require an enormous amount of resources mainly due to necessity of taxonomist employment. To reduce time and economic efforts, several opinions have been proposed by Duelli *et al.*, (1999) such as reducing the analysis to particular species groups (e.g. Carabidae beetles) and/or to a subset sampled in the most diverse annual season. Other alternative methods not requiring species identification have been suggested; such as the use of morphospecies (Oliver and Beattie, 1993 and 1996) and higher taxa categories (Gaston and Williams, 1993) as surrogates for species. Bambach and Sepkoski (1992), Williams and Gaston (1994), Balmford *et al.*, (1996) gave the opinion that the effectiveness of the higher

taxa approach depends on a strong correlation existing between higher taxa richness and species richness. Andersen (1995) remarked that the use of this approach provides obvious benefits in a context of limited financial and human resources and it is particularly useful, when rapid biodiversity surveys are required.

In the present investigation, diversity indices were worked out at the familial, genus and species level to find out whether surrogacy is possible as far as neuropteran diversity analysis are concerned. Shannon Weiner Index at familial level and genus level showed strong correlation in papaya, tapioca and sapota ecosystems, whereas genus and species level analysis revealed strong correlation in sapota, mango and papaya ecosystems. At familial level and species level strong correlation was observed in papaya followed by sapota and in tapioca ecosystems. With reference to Fisher's Alpha, analysis at familial and genus, genus and species level an identical pattern was recorded in rose, tapioca, papaya and guava. Moderate and weak relationships are observed in sapota and mango respectively. Analysis of species diversity using this index gave a clear picture of the within habit species diversity. At familial level and species level significant correlation was observed in rose, tapioca and in guava ecosystems. Margalef D index also presented similar results to Fischer index from correlation analysis. Calculation based on Brillouin's index revealed neuropteran diversity at familial level and genus level showed strong correlation in tapioca and papaya and moderate correlation in mango and rose ecosystems, whereas genus and species level analysis revealed significant correlation in papaya, mango and guava. At familial level and species level strong correlation was recorded in papaya followed by mango ecosystems.

Simpson's dominance index at familial level and genus level showed strong correlation in

papaya and moderate in tapioca and sapota ecosystems, whereas genus and species level analysis revealed strong correlation in rose and sapota ecosystems. At familial level and species level strong correlation was recorded in papaya ecosystem. Berger parker index at familial level and genus level showed strong correlation in mango and sapota. Genus and species level analysis also showed the same results. At familial level and species level strong correlation was recorded in papaya and mango ecosystems. The Berger–Parker index equals the inverse of true diversity of order infinity. In McIntosh index identical pattern was observed in papaya, sapota and tapioca at familial level and genus level but at species and genus level similarity was observed in sapota, mango and in guava. At familial level and species level strong correlation was observed in sapota followed by papaya and guava ecosystems. Equitability J indices were similar at terms of familial level and genus level in papaya and tapioca whereas at genus and species level pattern was identical in sapota followed by papaya and in mango ecosystems. At familial level and species level strong correlation was observed in papaya followed by sapota and tapioca ecosystems. The usage of higher taxa typically, family as surrogate for species has been suggested by Gaston and Williams (1993) and William and Gaston (1994). Hoback *et al.*, (1999) reported that ideally an estimate of diversity should examine organisms at species level, as any estimate of diversity at taxonomically higher level will be unable to explain the relationship between the species or population size or rate.

Different species of neuropterans *viz.*, *M. boninensis*, *C. zastrowi silemmi* *M. astur* and *Hemerobius* sp. dominated in different time intervals in rose ecosystem. In tapioca ecosystem *M. boninensis*, *C. zastrowi silemmi* and *M. astur* were dominant whereas *Hemerobius* sp. were less dominant. *M. boninensis* and *C. zastrowi silemmi* dominated

mainly in papaya ecosystem. In mango and sapota ecosystem *Hemerobius* sp. and *M. boninensis* were dominant. In guava ecosystem three sp. of neuropterans *viz.*, *C. zastrowi silemmi*, *M. boninensis* and *Hemerobius* sp. were equally sharing the ecosystem which indicates that ecosystem plays a major role in the survival of different organisms.

Rose ecosystem

In rose ecosystem results revealed that *Hemerobius* sp. dominated in September, October and in November (2012) followed by *C. zastrowi silemmi*. *M. boninensis* dominated in December (2012), January and in February (2013) months followed by *C. zastrowi silemmi* in December (2012) and *Hemerobius* sp. in February and March (2013) respectively. *Hemerobius* sp. dominated in April (2013) and in June (2013) but *M. boninensis* dominated in May (2013). *M. boninensis* dominated in July (2013) whereas *Hemerobius* sp. dominated in August and September (2013). In October and in November (2013) *M. boninensis* dominated followed by *Hemerobius* sp. whereas in December (2013) *Hemerobius* sp. dominated followed by *M. boninensis*.

Tapioca ecosystem

In tapioca ecosystem analysis of results revealed that *M. boninensis* dominated in September, October and in November (2012) months followed by *C. zastrowi silemmi* and *M. astur* whereas in December (2012) *C. zastrowi silemmi* dominated *M. boninensis*. In January (2013) *C. zastrowi silemmi* dominated followed by *M. boninensis* but in February (2013) *M. boninensis* dominated followed by *C. zastrowi silemmi* in the tapioca ecosystem. From March to December (2013) *M. boninensis* dominated completely. *Hemerobius* sp. were less abundant when,

compared to other sp. in the tapioca ecosystem.

Papaya ecosystem

From October (2012) to May (2013) *C. zastrowi silemmei* dominated followed by *M. boninensis* in papaya ecosystem. In June (2013) *M. boninensis* dominated followed by *C. zastrowi silemmei*. In July, August and in September (2013) *C. zastrowi silemmei* dominated followed by *M. boninensis*. In November and in December (2013) also *C. zastrowi silemmei* dominated followed by *M. boninensis*. *M. astur* and *Hemerobius* sp. were less abundant when compared to *C. zastrowi silemmei* and *M. boninensis* in papaya ecosystem.

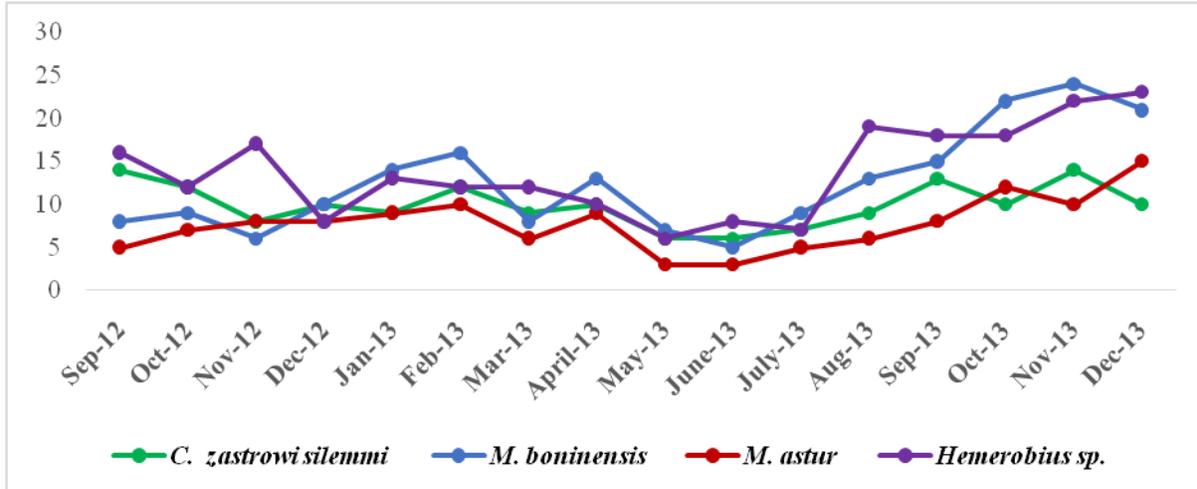
Mango ecosystem

Hemerobius sp. dominated in mango ecosystem from September (2012) to March (2013) followed by *M. boninensis* whereas *M. boninensis* dominated from April (2013) to June (2013) followed by *Hemerobius* sp. *Hemerobius* sp. dominated in July (2013) whereas from August to October *M. boninensis* dominated followed by *Hemerobius* sp. in mango ecosystem. In November (2013) *Hemerobius* sp. dominated followed by *M. boninensis* and in December (2013) *M. boninensis* dominated followed by *Hemerobius* sp. *C. zastrowi silemmei* and *M. astur* were comparatively less in mango system.

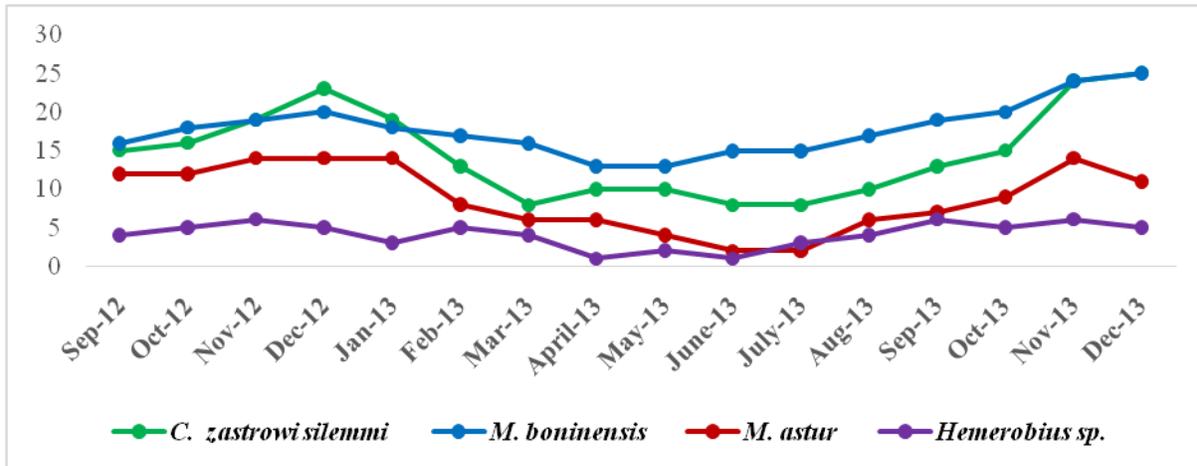
Table.1 Arthropods at ordinal level in horticultural ecosystems

Class	Order	Total	Grand total
Arachnidae	Araneae	84	101
	Acarinae	17	
Chilopoda	Scolopendridae	5	5
Diplopoda	Pentazonia	9	9
Insecta	Odonata	84	5517
	Orthoptera	112	
	Dictyoptera	94	
	Dermaptera	23	
	Hemiptera	386	
	Isoptera	14	
	Thysanoptera	13	
	Hymenoptera	248	
	Coleoptera	373	
	Diptera	122	
	Lepidoptera	146	
Neuroptera	3902		
Grand total			5632

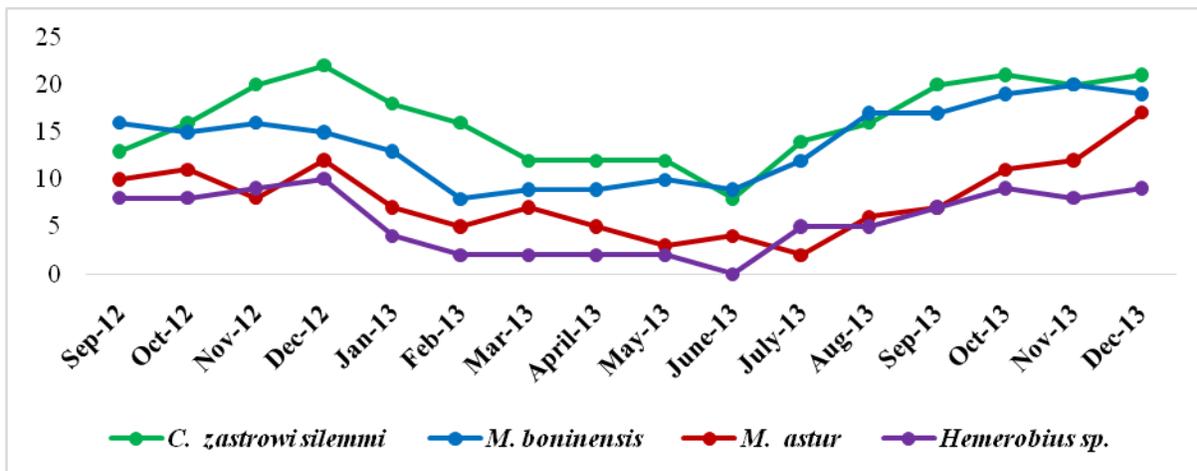
Fig.1 Seasonal abundance of different species of neuropterans in different ecosystems



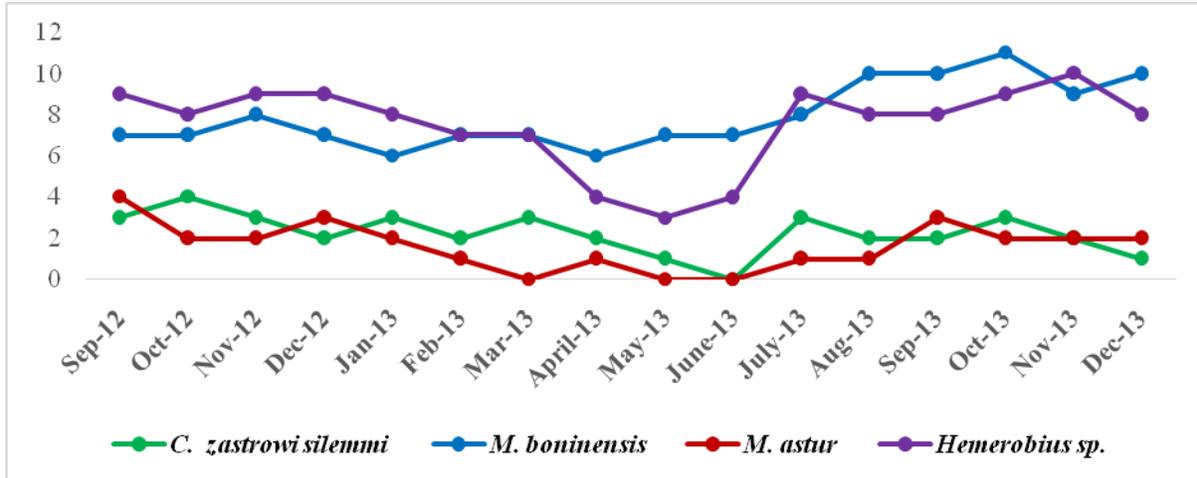
(Rose ecosystem)



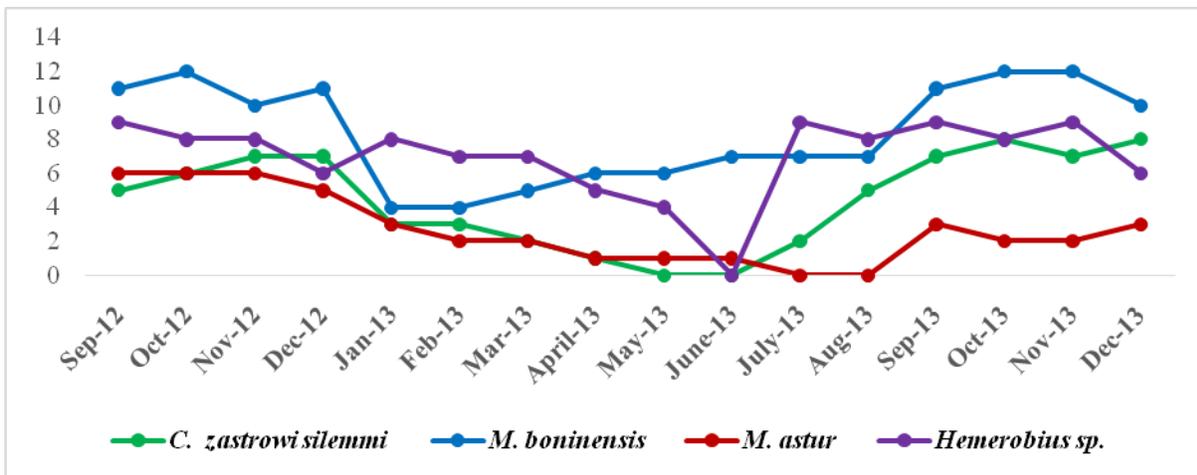
(Tapioca ecosystem)



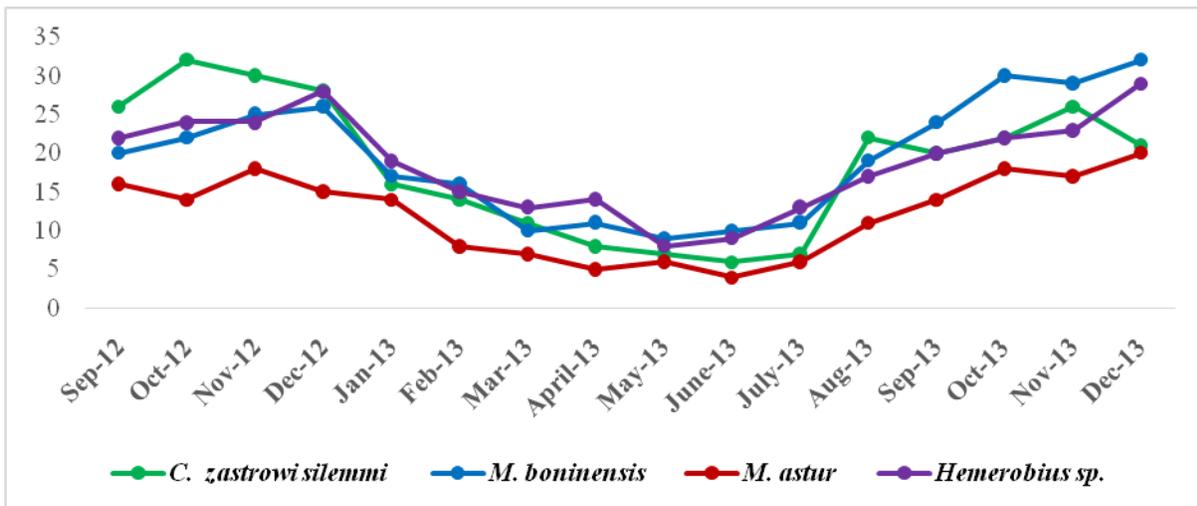
(Papaya ecosystem)



(Mango ecosystem)



(Sapota ecosystem)



(Guava ecosystem)

Sapota ecosystem

In sapota ecosystem *M. boninensis* dominated from September (2012) to December (2012) followed by *Hemerobius* sp whereas *Hemerobius* sp. dominated from January (2013) to April (2013) followed by *M. boninensis*. *C. zastrowi silemami* were not recorded in May and June (2013) months whereas *M. astur* were not recorded in July and August (2013) months. *Hemerobius* sp. dominated in July and in August (2013) followed by *M. boninensis*. From September to December *M. boninensis* dominated followed by *Hemerobius* sp and *C. zastrowi silemami*.

Guava ecosystem

Three sp. of neuropterans viz., *C. zastrowi silemami*, *M. boninensis* and *Hemerobius* sp. were equally dominant from September (2012) to December (2013) in guava ecosystem whereas *M. astur* was less dominant compared to the other three sp. of neuropterans in guava ecosystem.

Seasonal abundance of neuropterans in different ecosystems

Four different sp. of chrysopids viz., *C. zastrowi silemami*, *M. boninensis*, *M. astur* and *Hemerobius* sp. were recorded in all the six ecosystems.

The population of chrysopids was found maximum during the first fortnight of November and December when the temperatures were low and relative humidity was high at the same time the natural population of insects viz., mango hoppers, mealy bugs, scales and thrips were higher on mango trees. The activity of predator remained low during high temperature in the month of April to August (More *et al.*, 2011). In the present study almost in all the ecosystems surveyed viz., rose, tapioca, papaya, mango, sapota and guava, neuropterans were abundantly present during November and December months and low in number during April, May and June months.

Rose ecosystem

More number of four sp. of chrysopids viz., *C. zastrowi silemami*, *M. boninensis*, *M. astur* and *Hemerobius* sp. were recorded in November (2013) followed by December (2013) and in October (2013) whereas less numbers were recorded in May and in June (2013) months in rose ecosystem (Fig. 1).

Tapioca ecosystem

Four different sp. of chrysopids viz., *C. zastrowi silemami*, *M. boninensis*, *M. astur* and *Hemerobius* sp. were recorded in tapioca ecosystem. More numbers of chrysopids were recorded in November (2013), December (2013) followed by November (2012) whereas less numbers were recorded in May, June and in July (2013) months respectively (Fig. 1).

Papaya ecosystem

More number of chrysopids were recorded from October to December (2013) followed by November and in December (2012) whereas less numbers were recorded in June (2013) (Fig. 1).

Mango ecosystem

Chrysopids were relatively more in October and in November (2013) followed by November and December (2012) and relatively less numbers were recorded in May and June months (2013) respectively (Fig. 1).

Sapota ecosystem

More number of chrysopids were recorded from October to December (2012) followed by September to December (2013) whereas less numbers were recorded in May and June months (2013) (Fig. 1).

Guava ecosystem

Chrysopids were relatively more in October to December (2013) and in November to

December (2012) and relatively less numbers were recorded in May and June months (2013) respectively (Fig. 1).

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