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RECKONING OF SPIDER BIODIVERSITY IN BHENDI [*ABELMOSCHUS ESCULENTUS* L. (MOENCH)] ECOSYSTEM

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ABSTRACT
Field surveys were conducted to explore the diversity and abundance of spider fauna in bhendi ecosystem. A total of 24 spider species under 16 genera and 7 families were observed in the bhendi ecosystem. Amongst the spider families, the family araneidae was more diversed consists of maximum 6 species followed by oxyopidae (5 species), salticidae (5 species), tetragnathidae (3 species), lycosidae (2 species), thomisidae (2 species) and clubionidae (1 species). Amongst the different families, salticidae was relatively abundant (36.40 and 28.71% in *kharif* and *rabi* respectively) than other families. The species richness (R) of spiders during *kharif* (2.92) was more than *rabi* (2.60) seasons. The species evenness (J), Shannon and Wiener diversity index (H′) and Simpson index (ë) of spiders were 0.60 and 0.64, 1.71 and 1.74 and 0.21 and 0.19 during *kharif* and *rabi* respectively, indicating the more or less similarity in both the seasons. It was concluded that species richness of spider during *kharif* was found to be abundant compared to the *rabi* season and species diversity indices and species evenness indices were more or less equal and exhibited a similar diversification in both the seasons.

INTRODUCTION

Spiders are key predators in terrestrial ecosystems and are a mega diverse group with more than 40,000 described species, occurring in all continents except Antarctica (Platnick, 2013). Araneae are sensitive to environmental alteration and, as generalist predators, influence herbivore and detritivore populations, so their abundance and richness can reflect those of taxonomic groups belonging to lower trophic levels (New, 1999). Moreover, spiders can explore a myriad of environments, occupy a key position in a variety of food webs, and are ubiquitous and relatively easy to collect and identify to morphospecies (Oliver and Beattie, 1993).

They play an important role in regulating insect pests in agriculture ecosystems. Spider feed on insect and other Arthropods. A total of 35000 spider species have been identified in the world (Ghavami, 2007). Two distinct types of population structures are present in many spider species, each with different characteristics regarding dynamics and behaviour (Uetz *et al.,* 1999). Although spiders are generalist predators, they can be seen as a group of specialised predators, if their different ecological niches are taken into account (Marc and Canard, 1997). Therefore, spiders are extremely important in maintaining pests' densities at low levels, having an important role in pest limitation in agro-ecosystems (Marc *et al.,* 1999). Most preferred food of spiders is found to be ants, followed by houseflies, mosquitoes, beetles, butterflies, honeybees, *etc.* Habitat diversity around the fields enhances migration from the orchard's surroundings, allowing recolonisation of the agro-ecosystem (Bishop and Riechert, 1990). Studies on Indian spider fauna have been carried out by different workers (Mahalakshmi and Jeyaparvathi, 2014). According to Siliwal *et al.* (2005) about 1442 valid species of spiders are known from India and according to Keswani *et al.* (2012), the known spider species from India are 1686. Spider catches a special attention of the naturalists because of their different types of web architecture to trap different insects for food (Codington and Levi, 1991). Despite their fundamental role in natural ecosystem they have largely been ignored in conservational studies. Since information on spiders in bhendi ecosystem is lacking this study is an attempt to provide base line information on spiders for further studies.

MATERIALS AND METHODS

Two field experiments were conducted to inventorize the spider fauna in bhendi during *kharif,* 2012 and *rabi,* 2012-13 at East farm of Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA and RI), Karaikal, U. T. of Puducherry. The farm lies between 10° 55 N latitude and 79º52 E longitudes with an altitude of 4 M above MSL. The variety MH 10 was used. The agronomic practices were carried out as per the crop production guide of Tamil Nadu Agricultural University (TNAU), Coimbatore, India.

Many previous studies on spider diversity have focused on fauna from a subset of the habitat, such as the ground,

canopy or foliage (Draney, 1997 and Corey *et al.,* 1998). In this study, we collected spiders from the ground and canopy layers in order to have a comprehensive representation of diversity from all microhabitats in the plot. Attempts were made to carefully scan the leaf litter surface, foliage (including the under surface of leaves when traces of webs were found) twigs, and branches of the vegetation.

The surveillance of bhendi crop was initiated at the seedling emergence of the crop and continued until the last picking. Insect fauna were collected in the early hours of the day between 6:00 am to 8:00 am at weekly intervals. Spiders were collected by adopting standard sampling techniques such as sweep netting (32 cm dia. and 70 cm long), beating sheets, active searching and hand picking and umbrella collection.

The specimens were transferred into a container having 70% ethyl alcohol, before being brought to the laboratory. Collected specimens were washed with xylene and each specimen was preserved in a separate vial in 95% ethyl alcohol with little glycerine.

Identification was done on the basis of morphometric characters of various body parts using stereo zoom microscopes for studying identification keys. All samples of spiders were identified by following the keys and catalogues of Tikader (1987) and Platnick (2010), and through expert identification comments. All the specimens were labelled with family, scientific name, date of collection. At the completion of study, all the specimens were housed in the department insectaries.

Estimation of relative abundance

It measures the percentage of individuals over all the species. It was measured by the formula,

$$R = \frac{a}{N} X\ 100$$ (Singh and Rai, 2000)

Where,

R = Relative abundance

a = Total population of a particular species/taxon

N = Total population of all the species/taxon

Note : It measures the percentage of individuals over all the species

Estimation of biodiversity indices

Complete counts of organisms is not practicable and hence indirect solution was adopted for practical purpose to measure biodiversity of a community.

Simpson index

It is an index that focuses on the dominance aspect of a community, for example communities where only one or few species are dominant and most are very rare (Simpson, 1949).

$$\lambda = \sum_{i=1}^{s} \frac{n_i (n_i - 1)}{n (n - 1)}$$

Where,

nb" = Number of individual of the i^{th} species

n = Total number of individuals in the sample

Note : If the value of 'ë' decreases, diversity will increase

Shannon-Wiener

In order 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). It is, also, a nonparametric measure of heterogeneity. It is the most popular measures of species diversity and it is based on information theory. The main objective of information theory is to try to measure the amount of order (or disorder) contained in a system.

$$H = -\sum_{n}^{s} \left[\frac{[ni]}{n} \right] X \ln \left[\frac{ni}{n} \right]$$ (Shannon and Wiener, 1949)

Where,

n_i = Number of individuals belonging to the i^{th} species

n = Total number of individuals in the sample

ln = Natural logarithm

Species evenness (J)

How equally abundant the species are. There are many measures of evenness proposed. One of the most common approaches has been to scale one of the heterogeneity measures such as the Shannon-Wiener Diversity measure above, relative to its maximum theoretical value when each species in the sample is represented by the same number of individuals.

$$J = \frac{H}{\ln (s)}$$ (Pielou, 1969).

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

Species richness (R)

In order to assess how the diversity of the population is distributed or organised among the particular species, this index was calculated.

$$R = \frac{S - 1}{\ln (N)}$$ (Margalef, 1958)

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

RESULTS AND DISCUSSION

Spiders collected at weekly intervals during *kharif,* 2012 and *rabi,* 2012-13 seasons from the bhendi ecosystem were identified to the extent of possible taxons (family, genus and species levels) and are presented in Table 1.

A total of 24 spider species were recorded in the bhendi ecosystem. Among them, a total of 16 genera and 7 families were observed in the bhendi ecosystem. Amongst the spider families, the family araneidae consists of maximum 6 species followed by oxyopidae (5 species), salticidae (5 species), tetragnathidae (3 species), lycosidae (2 species), thomisidae (2 species) and clubionidae (1 species) (Figure 2).

Relative abundance

A total number of 239 individuals were recorded from the survey comprising 17 taxons during *kharif*, 2012. In *rabi*, 2012-13, a total number of 216 individuals were recorded from the

Table 1: Inventory of spider fauna in bhendi ecosystem

Family	Species	Guild	*Kharif*	*Rabi*
Araneidae	*Araneus* sp.	Orb web spider	√	√
	Argiope catenulata Doleschall	Orb web spider	X	√
	Argiope pulchella Thorell	Orb web spider	√	X
	Cyrptophora citricola Forskål	Orb web spider	√	X
	Neoscona elliptica Tikader	Orb web spider	√	√
	Neoscona nautical Koch	Orb web spider	√	√
Clubionidae	*Clubiona drassodes* Cambridge	Patchy sac spider	X	√
Lycosidae	*Lycosa mackenziei* Gravely	Ground runner	√	
	Pardosa sp.	Ground runner	√	√
Oxyopidae	*Oxyopes javanus* Thorell	White lynx spider		√
	Oxyopes ratnae Tikader	White lynx spider	√	X
	Oxyopes birmanicus Thorell	White lynx spider	√	X
	Oxyopes indicus Walckenaer	White lynx spider	√	X
	Oxyopes shweta Tikader	White lynx spider	X	√
Salticidae	*Cosmophasis umbratica* Simon	Jumping spider	X	√
	Menemerus bivittatus Dufour	Jumping spider	X	√
	Myrmarachne orientalis Tikader	Jumping spider	√	X
	Myrmarachne plataleoides Cambridge	Jumping spider	√	√
	Plexipus paykulli Audouin	Jumping spider	√	X
Tetragnathidae	*Leucauge venusta* Walckenaer	Orb web spider	√	√
	Opadometa fastigata Simon	Orb web spider	√	√
	Tetragnatha javana Thorell	Orb web spider	√	X
Thomisidae	*Thomisus cherapunjens* Tikader	Foliage dweller	√	√
	Thomisus pugilis Stoliczka	Foliage dweller	X	√

Note: √ - Present X- Absent

Table 2: Relative abundance of spider families

Sl. No.	Family	No. of individuals (*Kharif*)	Relative abundance (*Kharif*)	No. of individuals (*Rabi*)	Relative abundance (*Rabi*)
1.	Araneidae	34	14.22	22	10.18
2.	Clubionidae	13	5.45	7	3.24
3.	Lycosidae	9	3.77	30	13.89
4.	Oxyopidae	41	17.15	36	16.67
5.	Salticidae	87	36.40	62	28.71
6.	Tetragnathidae	19	7.95	8	3.70
7.	Thomisidae	36	15.06	51	23.61

Table 3: Comparison of diversity, evenness and richness of major insects in bhendi

Season	S	N	RA (%)	J	R	H	ë
Kharif	17	239	52.53	0.60	2.92	1.71	0.21
Rabi	15	216	47.47	0.64	2.60	1.74	0.19

Note: S- No. of species, N- Total no. of individuals in all families, RA- Relative abundance, J- Species Evenness, R- Species Richness, H- Shannon-Wiener index, ë - Simpson's Index

survey comprising 15 taxons (Table 3).

In *kharif*, it was recorded that, the relative abundance of salticidae, oxyopidae, thomisidae, araneidae, tetragnathidae, clubionidae and lycosidae were 36.40, 17.15, 15.06, 14.22, 7.95, 5.45 and 3.77 per cent respectively. It was observed that the family salticidae was relatively abundant followed by other families. In *rabi*, it was recorded that, the relative abundance of salticidae, thomisidae, oxyopidae, lycosidae, araneidae, tetragnathidae and clubionidae were 28.71, 23.61, 16.67, 13.89, 10.18, 3.70 and 3.24 per cent respectively. It was observed that the family salticidae was relatively abundant followed by other families (Figure 1). It was found that the spiders in *kharif* season (52.53%) were relatively abundant followed by *rabi* season (47.47%).

Biodiversity indices

Based on the primary data, four different indices namely Simpson index (ë), Shannon-Wiener (H) index, Species evenness (J), Species richness (R) had been calculated for spiders during *kharif,* 2012 and *rabi*, 2012-13 and are presented in Table 3.

Species richness index R (Margalef) included total number of individuals apart from number of species. According to this index, species richness of spiders were 2.92 and 2.60 during *kharif* and *rabi* respectively. It was found that, the species richness of spiders during *kharif* was more than *rabi* seasons.

The evenness index (J) of spiders were 0.60 and 0.64 during *kharif* and *rabi* respectively indicating more or less similarity during both the seasons.

Shannon and Wiener diversity index (H') is the most popular

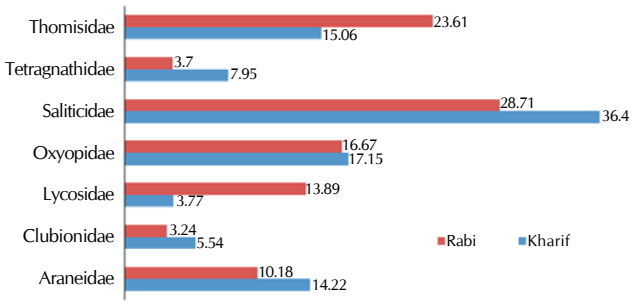

Figure 1: Distribution of spider families in bhendi ecosystem

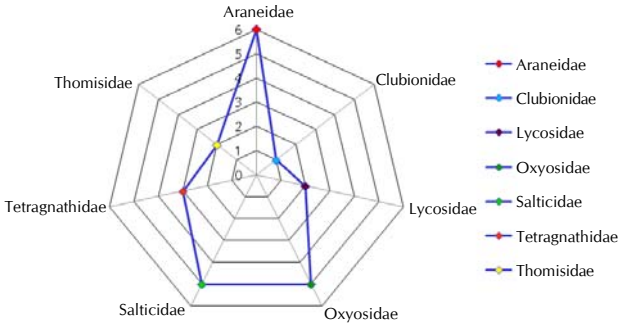

Figure 2: Distribution of spider species in bhendi ecosystem

and widely used index in community ecology. It is the average degree of 'uncertainity' and if this average 'uncertainity' increases as the number of species increase and distribution of individuals among the species also become even. It was observed that the Shannon and Wiener diversity index (H') of spiders were 1.71 and 1.74 during *kharif* and *rabi* respectively, indicating the more or less similar diversification in both the seasons.

Simpson index (ë) measures the strength of dominance, because it weighs towards the abundance of the most common species and varies inversely with species diversity (Whittaker 1972). A value of this index ranges from 0 to 1; zero represents no dominance and 1 for maximum dominance *viz*., only one species in the sample (Berger and Parker 1970). The diversity values (ë) of spiders during *kharif* and *rabi* were 0.21 and 0.19 respectively, indicated that the diversity was more or less equal.

Mahal *et al*. (1994) reported that spiders, ants and beetles played significant role in balancing the population of harmful insects in bhendi. Mishra & Mishra (2002), Ravikumar *et al*. (2003), Rajpal & Joshi (2003), Bhushan *et al*. (2011) reported that, the spiders and beetles were the main defenders in bhendi ecosystem. A total of 60 families of spiders recorded in the Indian region (Sebastian and Peter, 2009).

Mandal *et al*. (2006) and Loknath *et al*. (2011) reported that, coleopteran was the most important predatory insects (42.44%) followed by spiders (30.23%) which was about 27.33 per cent of the total arthropods. The present findings are in corroborate with the above findings.

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