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ANALYSIS OF SPIDER DENSITY ACROSS SHEKHAWATI ARAVALIAN REGION OF RAJASTHAN, INDIA.

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ABSTRACT

Spiders have been regarded as good indicators of habitat quality due to higher sensitivity to change in their environment. Spiders are attractive because of their intriguing biology and they can be easily collected and maintained in laboratory. This article aims on monitoring the population structure and distribution of spider fauna in Shekhawati Aravalian region of Rajasthan, India by focusing on two parameters: richness of spiders per habitat and percent abundance of families within each habitat across four habitat types. A total of 328 spiders were collected during field survey which was made from March, 2010 to February, 2012. Data so collected from eight sampling sites were subjected to statistical analysis. Results indicated the maximum species richness (25.96) and Shannon index value (3.18) in woodland due to its dense plant canopy and availability of more preys. The small population size in caves/rocks may be due to scarce vegetation and limited space for web formation. It was concluded that spider communities fluctuated in these habitat types due to different ecological conditions.

Key words: arthropods, population, richness, evenness, habitat.

INTRODUCTION

Animals which are mobile during various developing stages of their life, actively select a suitable site for nesting, feeding and reproduction. The fitness of an animal is directly influenced by its ability to find a suitable habitat which is based on an innate preference for certain conditions e.g. availability of food, shelter and absence of enemies. Environment exerts a strong influence on habitat selection in spiders. Diversity of spiders shows certain associations between their population composition and structural complexity of the plant community (Chew, 1961; Riechert and Reeder, 1970). Spiders have close relationship with their surrounding because they need attachment sites for their webs and their sensory organs can recognize the tactile vibrations of the substrate (Rovner and Barth, 1981; Uetz and Stratton, 1982). They have higher host finding ability and capacity to consume greater number of prey than other field inhabiting predators (Kamal *et. al*, 1990). Spiders have been reported to occur in abundance over 1000 per meter square (Ellenberg *et al*., 1986). Food resources are patchily distributed for most animals, regulating their abundance, feeding behavior, population dynamics and ultimately their evolution (Bronstein, 1995). The use of spiders as an indicator species has supported research of more widespread environmental changes. Similarly they use the environmental elements as indicators of prey availability, e.g. plant flowering (Pollard *et al*., 1995).

About 36000 valid species belonging to 3050 genera and 106 families have been described, although major part of spider diversity still remains undiscovered. As of today the North American, West European and Japanese spider fauna are better known, but the tropical, south temperate, Australian and Indian fauna are still very poorly reported. Currently there are very few workers actively involved in surveying and recording Indian spiders (Ganesh Kumar and Mohan Sundram, 1998). Poornima (2001) observed relative abundance of major arboreal spider families in the central Western Ghats. Conniff (2001) commented that up to 170000 species could exist. In recent past, artificial multiplication and inundative release of entomophages and spiders for the integrated management of pests have shown success against the limited number of pests. This is largely because of their limitation of not being able to perpetuate their progeny in adequate numbers as well as lack of knowledge about their ecological requirements. Spiders have also been used in the study of habitat structure, where they have been found to vary with moisture levels and canopy cover (Hore and Uniyal, 2008). Hence there is a dire need of information regarding species composition, distribution pattern and feeding behavior of the spider fauna to ascertain their beneficial role in natural ecosystems. During present study, the field observations in Shekhawati Aravalian region of Rajasthan, India have shown a quantitative association of spider communities across four distinct habitat types.

MATERIALS AND METHODS

A. Study area: The research work was conducted in Shekhawati Aravalian region of Rajasthan. Shekhawati region includes Sikar and Jhunjhunu districts of Rajasthan, located at 27°37´ north to 75°9´east (fig. 1). The study area is dry tropical deciduous type. Maximum and minimum temperature recorded in winter and summer was 27°c and 4°c and 47°c and 15°c, respectively and average relative humidity (RH) was 54.8 percent. Eight sampling transects comprising of four habitat types: woodland, marshy area, pasture and caves/rocks were selected to record the spider diversity of the experimental region. In order to estimate the synchrony between plant canopy and spider densities, we compared the plant abundance of all four habitat types. Two transects of matching characteristics (vegetation, canopy cover, etc.) were selected for each type of habitat and a short summary of their geographical location and the characteristic vegetation is given in Table 1. Woodland habitat was selected in two transects –forest area of Udaipurwati (Jhunjhunu) and Patan (Sikar). Marshy habitat was selected in two transects – Narsinghpuri pond area (Sikar) and Raipur dam area (Neemkathana). Pasture habitat selected in two transects Areas around Kantali river in Guhala and Khandela.

B. Collection: Spiders were collected from eight sites consisting of four types of habitats. Collections were made from March, 2010 to Feb, 2012, using various methods such as pitfall trapping, sweep netting, cryptic searching and ground hand collection. Most methods were applied during day from 7 a.m. to 10 a.m. and 5 p.m. to 7 p.m. during summer and 7 a.m. to 10 a.m. and 4 p.m. to 6 p.m. during winter.

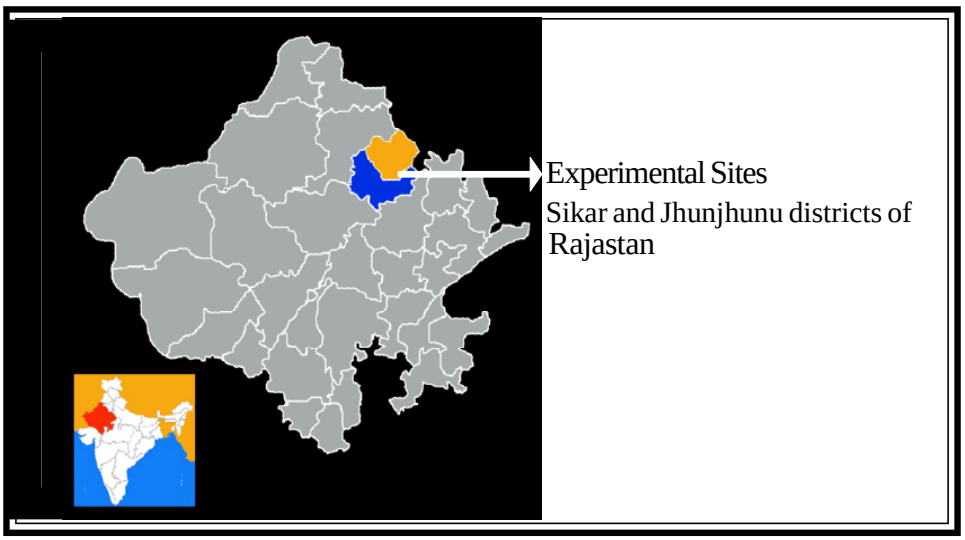

Table 1. An outline of habitat site details.

Habitat	*Geographical location*	*Dominant plant species*
Woodland	Area of Udaipurwati (Jhunjhunu) and Patan (Sikar)	*Acacia nilotica* (Babool), *A. arabica*, *Prosopis sinereria* (Khejri), *P. juliflore*, *Tecomella undulata*, *Dulerzia sisoo* (Sheesham)
Marshy area	Narsinghpuri pond area and Raipur dam area (Sikar)	*Ipomoea reptans*, *Cyprus*, *Cynodon dactylon*
Pasture	Area of Chala (Sikar) and Guda (Jhunjhunu)	*Cyanodon dactylon* (Doob grass), *Leciurus sindicus* (Sevan grass), *Pedalium murex* (Badad gokhru), *Tribulus terrestris* (Chhota gokhru)
Caves/Rocks	Area around Katali river in Guhala and Khandela (Sikar)	*Opuntia*, *Cactus*, *Saccharum munza*, *Euphorbia*, *Caparis decidua*, *Zizyphus zuzuba*.

C. Identification: The collected spiders were preserved and identified up to species level when possible using taxonomic keys of Pocock (1903), Tikader and Malhotra (1980), Tikader and Biswas (1981), Tikader (1977, 1980, 1982, 1987), Murphy (2000), as well as picture guide to identification (Levi, 2002) and resources on biology and behaviour (Foelix, 1996). Because of the difficulty of identifying juveniles, only adults were identified and used in subsequent analyses. The collected spider specimens were preserved in 70 % ethyl alcohol with a few drops of glycerin (Prasad, 1985) and stored in laboratory for reference.

D. Statistical analysis: Spider assemblages were analyzed using two parameters i.e. total diversity of spiders per habitat and percent abundance of families in each habitat. Analysis of spider diversity across each habitat type was processed using a number of statistical measures as given below -

(i) **Species richness -** The measurement of species richness (S) is just a count of the number of species found within sampling sites during collection. Species richness was calculated by using following formula.

Species richness (S) = $n + (^{n}_{n}{}^{-1})^{k}$

Where, n = Total number of species present in sample population.

k = number of "unique" species (of which only one organism was found in sample population).

(ii) **Shannon index-** Sometimes it is referred as the Shannon Weiner Index or information index, is simply the information about the distribution and relative population size of species.

Shannon index (H') = -"Pi × In Pi

Where, Pi = proportion of individuals of given species

InPi = natural log of Pi

(iii) **Evenness** - To observe the evenness among species of a particular habitat, Evenness index value (E) was calculated using the H' value as following-

$$E = \frac{H'}{In\ S}$$

Where, H'= Shannon Index value

In S= natural log of richness

Species evenness ranges from zero to one, with zero signifying no evenness and one a complete evenness.

(iv) **Simpson's diversity index-** The most common measurement used for working out species diversity with the degree of disturbance is the Simpson's diversity index (D); which can be calculated by using the following formula-

$$D = 1 - \frac{ni-1}{N(N-1)}$$

Where, D = Simpson's diversity index

ni = number of individuals of species i

N = total number of individuals of all species

As predicted by the intermediate hypothesis, a high D value suggests a site that has undergone intermediate disturbance while a low D value suggests protection from disturbance.

RESULTS AND DISCUSSION

The percent abundance of spider families within each habitat is outlined in Table 2. and summarized in figure 2. In woodland family Araneidae, Salticidae and Oxyopidae were found as most abundant families to be 24.79, 16.52 and 15.70%, respectively. Family Araneidae was found as most abundant in both marshy and pasture having 28.12% and 23.07% abundance, respectively. In caves/rocks family Pholcidae and Lycosidae were found as most abundant being 29.23 and 20% respectively. Thus in present study, the distribution of some families was found to be continuous (Araenidae, Salticidae), while some had very discontinuous distribution. Poornima (2001) observed similar result on relative abundance of spider families among garden crops of Western Ghats of India, showing Araneidae and Salticidae as most abundant families having 25 and 11% relative abundance, respectively. Coloration in spiders varies extensively amongest the species due to different environmental factors (Hoese, *et al*., 2006).

A total of 328 spiders representing 12 families and 32 distinct species were recorded and identified during investigation. Spiders had two periods of increased population size occurring in early and late summer when ambient temperature ranged

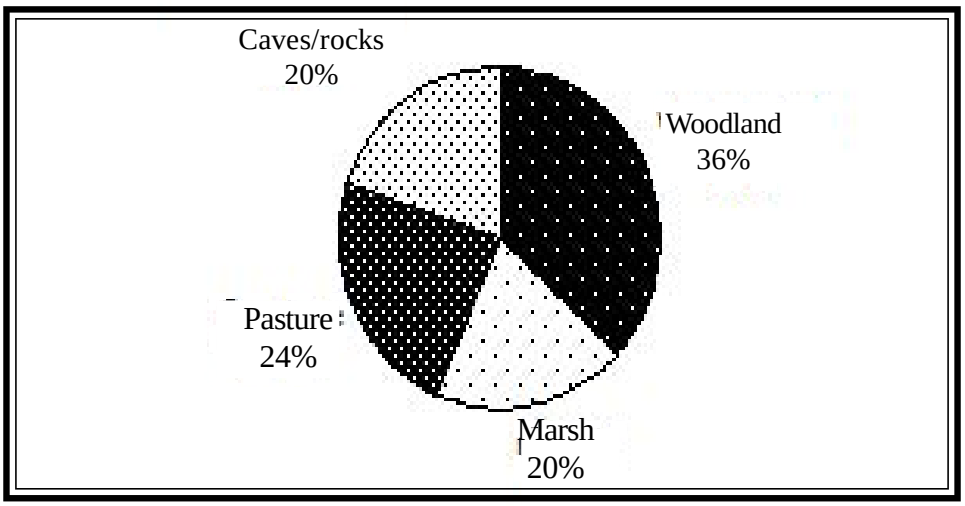

Figure-1, Percent abundance of spiders in each habitat

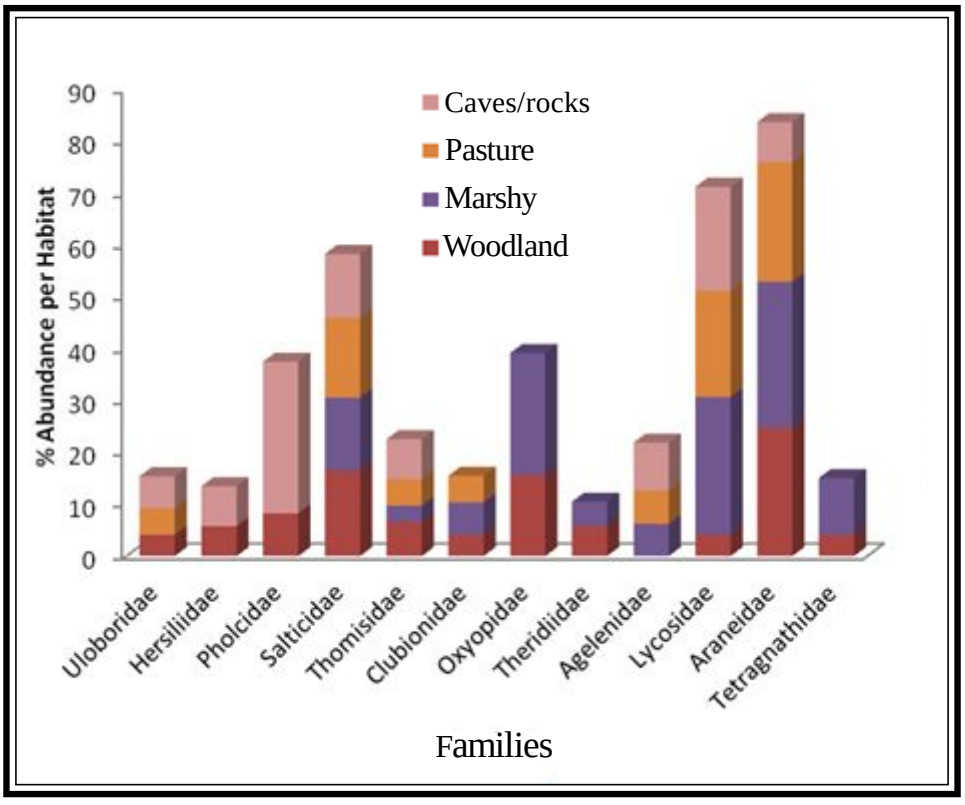

Figure-2, Percent abundance of spider families in each habitat

Table-2, Percent abundance of spider families in each habitat

Sr.No.	Family	Percent abundance of spider families within each habitat			
		Woodland %	Marshi area %	Pasture %	Caves/rocks %
1	Uloboridae	4.13	-	5.12	6.15
2	Hersiliidae	5.78	-	-	7.69
3	Pholcidae	8.26	-	-	29.23
4	Salticidae	16.52	14.06	15.38	12.30
5	Thomisidae	6.61	3.12	5.12	7.69
6	Clubionidae	4.13	6.24	5.12	-
7	Oxyopidae	15.70	23.43	-	-
8	Theridiidae	5.78	4.68	-	-
9	Agelenidae	-	6.24	6.41	9.23
10	Lycosidae	4.13	26.56	20.51	20
11	Araneidae	24.79	28.12	23.07	7.69
12	Tetragnathidae	4.13	10.93	-	-

Table-3, Summary of statistical analysis performed on the study data.

Statistical-measures	Habitat type			
	Woodland	Marshi area	Pasture	Caves/rocks
Richness(S)	25.96	18.94	17.94	12.91
Shannon-Wiener Index(H')	3.18	2.77	2.69	2.44
Evenness(E)	0.97	0.94	0.93	0.95 0.
Simpson-diversity Index(D)	9(Low)	0.9(Low)	0.9(Low)	0.9(Low)
	1.0(High)	1.0(High)	1.0(High)	1.0(High)

from 20° to 25°C. A complete record of spider abundance within each sampling site viz. woodland, marshy area, pasture and caves/rocks, is summarized in Figure -1. A synchronization was found between plant canopy and spider densities because the maximum percentage of spiders (36%) was found in woodland having dense plant canopy and the minimum number of spiders (20%) was found in caves/rocks and marshy area as mentioned in pie chart. Bajaj and Sadana (1977) reported fifteen species of spiders from cotton fields at Ludhiana. Dondale *et al.* (1979) reported 41 species of spiders in 6- year study in a Quabec apple orchard. Considering these aspects it was concluded that Shekhawati Aravalian region of Rajasthan is also a site of rich diversity of araneofauna.

Bonte *et al*. (2002) considered as true indicator species only those, which are found in the respective habitat throughout the year independently of their abundance. The possible inclusion of additional diversity measures in subsequent studies may yield more fitting or consistent results, as no single index could perfectly reflect the diversity of a given species (Routledge, 1979). Because of this, a number of measures were employed to analyze the data from this study. The species richness, Shannon-Weiner index (H'), species evenness (E) and Simpson diversity index (D) were calculated for each habitat type (Table- 3).

Since species distribution is correlated with factors such as temperature, humidity and distinctive plant growth (Koponen, 1991), relatively higher species richness and Shannon index value were recorded in woodland having dense plant canopy (S=25.96; H'=3.18). In contrast, caves/rocks were found to be sites of lower richness and Shannon index value (S=12.91; H'=2.44) containing fewest distinct species. The least number of species in caves/rocks can be explained for scarce vegetation as well as limited space for web building. Thus it was concluded that spider communities fluctuated as increase or decrease in these habitat types due to the different ecological conditions.

As generic diversity 29 genera have been reported from Jhalana Forest range of Jaipur region by Singh and Sihag (2007), whereas 25 genera have been reported from distinct habitat sites of Shekhawati Aravalian region of Rajasthan by Saini *et al* (2012). Intermediate disturbance hypothesis supported *Hersilia savignyii*, *Telmonia vittata, Pardosa sumatrana* and *Oxyopes shweta* to be protected from disturbance having low D value (D=0.9). In contrast, *Xysticus minutus*, *Plexippus paykullii, Aranius bituberculatus* and *Agelena* sps. were found undergone in intermediate disturbance having high D value (D=1.0).

CONCLUSION

The present study is the baseline information over the ecology, importance and the threats faced by the spider species in experimental region. Structurally more complex herbs and shrubs can support more spider communities. Oxyopids, Thomisids, Uloborids, Salticids etc. are some of the expert silent predators that are seen feeding on small insects like aphids, hoppers, beetles etc. They are maintaining ecological equilibrium by suppressing insect population. Thus efforts can be laid to rear spiders and use them as biocontrolling agents. It is also seen that adaptation to the various environment has facilitated them to survive in broad functional group. The study shows information related to the species distribution in a particular habitat with response to environment, disturbance and availability of food.

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