Diversity and distribution of spider fauna in arid and semi-arid region of Rajasthan

Vinod Kumari*, Kailash Chand Saini and N. P. Singh

ABSTRACT

The knowledge on diversity and distribution of spiders in Rajasthan is sparse as compared to other regions. There is a dire need of research regarding species composition, distribution pattern so that their role in controlling insect pests could be ascertained. Present study examined a novel approach for documenting the diversity of spider fauna in arid and semi- arid (Ajmer and Jodhpur) region of Rajasthan, India. A regular survey of spider faunal complex was conducted in four major habitats namely, woodland, wetland, pasture and caves/crevices/rocky area. Maximum number of spiders was found in woodland habitat and the minimum number of spiders were collected and identified from caves/crevices/rocky area with 31.86 and 17.61 relative abundance, respectively. Similarly, diversity indices *viz.*, richness, evenness, Shannon-Weiner and Simpson index also indicated the maximum species richness in woodland and minimum in caves/crevices/rocky area. In woodland, Araneidae and Oxyopidae were found as most abundant families with 41.44 and 15.78 percent of total spider fauna while Lycosidae was found as the most abundant family in wetland but was at par with Araneidae in pasture habitats. In Caves/crevices/rocky area, family Pholcidae was found as the most abundant.

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INTRODUCTION

Biodiversity, or simply diversity, is defined as the number of *taxa* in an area and is also used as a measure of variety of *taxa* in a community, considering the relative abundance of each *taxon* (Mineo and Claro, 2009). People are increasingly aware of threats to biodiversity and there is a growing need to conserve all species. However, meaningful conservation cannot take place if the species involved are not known (De Wet and Schoonbee, 1991). As a major element of global biodiversity (Wilson, 1987 and Chapman, 2009), arthropods provide fundamental functions in natural and modified ecosystems (Beare *et al*., 1992; Bradford *et al*., 2002) and they are increasingly being used in nature conservation management (Schmidt *et al*., 2008). One of the most diverse arthropod groups is spiders. Spiders comprise 46058 species worldwide (World Spider Catalog, 2016), being the second most diverse order of arachnids after mites (Coddington and Colwell, 2001; Francke, 2014) and appear to be good subjects for studying biodiversity patterns (Platnick, 1999).

The increased destruction of natural habitats by humans has intensified the need for collecting biodiversity data for support to conservation and management decisions. However, Rajasthan has remained poorly explored, and much of its diversity is being lost without any record. Research on the diversity patterns of spiders in Rajasthan (Nigam, 2004; Singh and Sihag, 2007; Chauhan *et al.*, 2009 and Saini *et al.*, 2012) is still in its infancy. This study is aimed at providing information on the species richness, diversity, and the distribution of spiders. This

is the first known report on the diversity and distribution of spider's fauna covering four different habitats *viz.*, woodland, wetland, pasture and caves/crevices/rocky area in Ajmer and Jodhpur district of Rajasthan, India. The data collected on the diversity and distribution of spiders in the present study will play important role in the use of spiders as a biocontrol agent in the integrated pest management in the study area.

MATERIALS AND METHODS

Study area

The research work was conducted in Ajmer and Jodhpur districts of Rajasthan (Fig. 1) from February 2014 to January 2015. 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 four habitat types *viz.*, woodland, marsh, pasture and caves/crevices/rocky area were selected to cover the spider diversity of the experimental region. Two transects of matching characteristics (vegetation, canopy cover, etc.) were selected for each type of habitat.

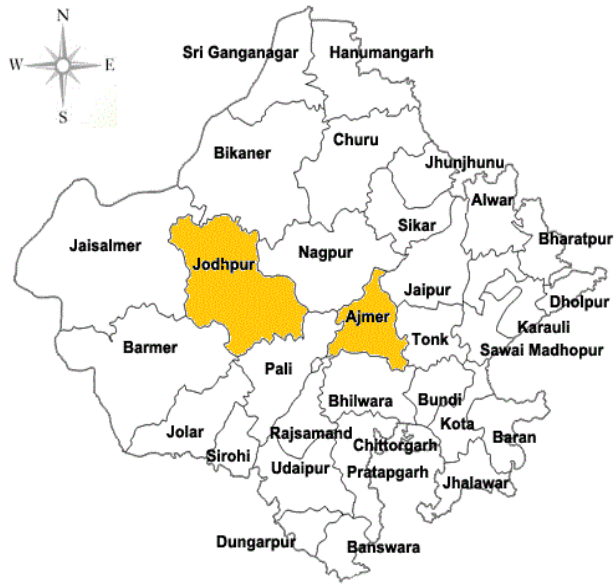

Fig. 1. Study area for diversity and distribution of spider fauna of Rajasthan

Sampling and collection

Line transect and quadrate method of sampling using visual search method as described by Sebastian *et al.* (2005) was adopted in the current study to sample the spider fauna from selected study sites. Spiders were collected by pitfall trapping, sweep netting, ground hand collecting, aerial hand collecting, vegetation beating, and litter sampling. Random sampling was done from the same selected study sites throughout the year during day from 6 a.m. to 9 a.m. and 5 p.m. to 7 p.m. in summer and 7 a.m. to 10 a.m. and 4 p.m. to 6 p.m. in winter.

Identification

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

Statistical analysis

Spider assemblages were analyzed using two parameters i.e. relative abundance of spider fauna and percent abundance of spider families per habitat. Analysis of spider diversity across each habitat type was proceeded by using statistical measures viz., Species richness (S), Shannon Index (H'), Evenness (E) and Simpson index (D) as described by Saini *et al*. (2012).

RESULTS

A total of 46 distinct species representing 17 families were recorded and identified during sampling (Table 1). Out of these, 32 species have been reported up to April, 2014 while the remaining 14 species were recorded from May, 2014 to January, 2015. Spiders have two periods of increased population size occurring in early and late summer when ambient temperature range from 20°C to 25°C. The relative abundance of spider families within each habitat is outlined in Fig. 2.

Table 1. Spider species collected from the various study areas

Family	Genus and Species	Common Name
Araneidae (Argiopidae)	1. *Cyclosa* sp.	Signature spider
	2. *Neoscona nautical*	Grey sphere spider
	3. *Neoscona excelsus* (Simon)	Orb web weaver
	4. *Neoscona pavida* (Simon)	Orb web weaver
	5. *Neoscona mukerjei* Tikader	Orb web weaver
	6. *Neoscona* sp.	Orb web weaver
	7. *Cyrtophora citricola* (Forskal)	Tent orb web weaver
	8. *Cyrtophora cicatrosa* (Stoliczka)	Tent orb web weaver
	9. *Zygeilla melanocronia* (Thorell)	Black-headed spider
	10. *Araneus bituberculatus*	Orb web weaver
Agelenidae	11. *Agelena* sp.	Funnel web spider
Clubionidae	12. *Chiracanthium danieli*	Leaf role spider
Eresidae	13. *Stegodyphus sarsinorum* Karsch	Social spider
Heteropodidae	14. *Heteropoda* sp.	Giant spider
Hersiliidae	15. *Hersilia savignyi* Lucas	Hunting spider
Lycosidae	16. *Pardosa sumatrana* (Thorell)	Wolf spider
	17. *Pardosa* sp.	Wolf spider
	18. *Hippasa agelenoides* (Simon)	Wolf spider
	19. *Hippasa pisaurina* (Pocock)	Wolf spider
	20. *Hippasa* sp.	Wolf spider
	21. *Lycosa* sp.	Wolf spider
	22. *Lycosa hilaris*	Wolf spider
	23. *Evippa praelongipes*	Wolf spider
Oecobiidae	24. *Oecobius putus* Cambridge	Ant eater
Oxyopidae	25. *Peucetia viridana* (Stoliczka)	Green lynx spider
	26. *Oxyopes shweta* Tikader	Lynx spider
	27. *Oxyopes sp.*	Termite eater
	28. *Oxyopes birmanicus* Thorell	Bermese lynx spider
Pholcidae	29. *Artema sp.*	Daddy long leg spider
	30. *Pholcus phalangioides* (Fuesslin)	Long bodied cellar spider
Salticidae	31. *Myrmarachne* sp.1	Ant mimic
	32. *Myrmarachne* sp.2	Ant mimic
	33. *Plexippus paykullii* (Savigny)	Domestic jumping spider
	34. *Telamonia vittata* (Koch)	Red jumper
	35. *Hasarius adansoni* (Audouin)	House jumper
Scytodidae	36. *Scytodes* sp.	Spitting spiders
Tetragnathidae	37. *Tetragnatha mandibulata* (Walckenaer)	Big jawed spider
	38. *Leucauge decorata* (Blackwall)	Orb weaving spider
	39. *Olios* sp.	Huntsman
Theridiidae	40. *Argyrodes* sp.	Mercury spider
	41. *Achaerenia mundula*	Rolled leaf spider
Thomisidae	42. *Thomisus projectus* Tikader	Crab spider
	43. *Tmarus* sp.	Twig node spider
	44. *Xysticus minutus* Tikader	Crab spider
Uloboridae	45. *Uloborus* sp.	Without venom spider
Gnaphosidae	46. *Gnaphosa* sp	Ground spider

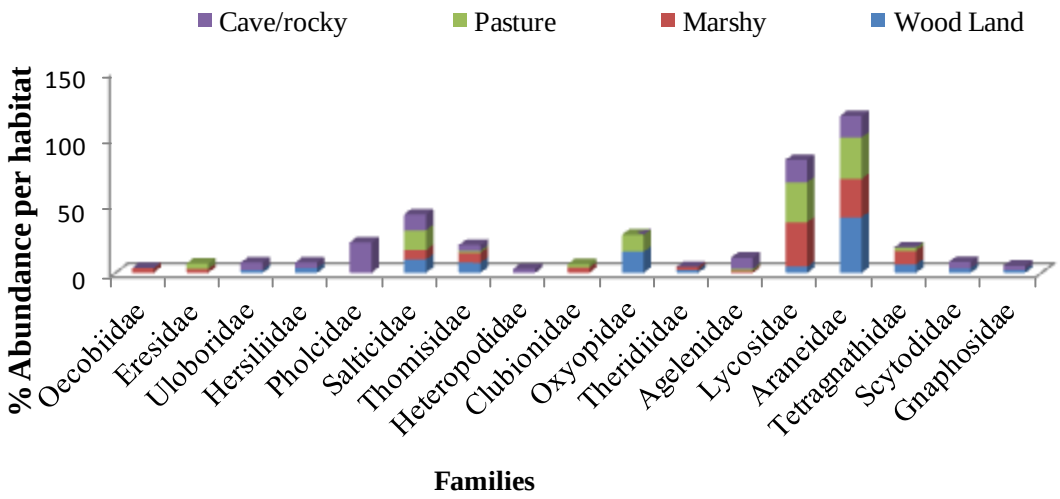

Fig. 2. Percent abundance of spider families in each habitat

In woodland, families Araneidae, Oxyopidae and Salticidae were found most abundant families (41.44, 15.78 and 9.86 % abundance, respectively). Families Lycosidae and Araneidae were found as most abundant families in both marshy and pasture having 33.09, 29.79 and 28.57, 30.80% abundance, respectively. In caves/crevices/rocky areas, Pholcidae and Lycosidae were found as most abundant spider families having 22.61% and 16.66% abundance, respectively. A complete record of spider's relative abundance within each sampling site *viz.*, woodland (31.86%), marshy area (29.76%), pasture (20.75%) and caves/crevices/rocky (17.61%) area. A synchrony was found between plant canopy and spider densities because the maximum percentage of spiders (31.86%) was found in woodland having dense plant canopy and the minimum percentage of spiders (17.61%) was found in caves/crevices/rocky area. The percent abundance of spiders in marshy area was found as 29.76% while in pasture it was found as 20.75%.

The statistical measures in diversity studies may yield more fitting or consistent results, but no single measure or index can perfectly reflect the diversity of a given area (Routledge, 1979). Because of this, number statistical measures were employed to analyze the data from the present study (Table 2). The diversity indices used here were Shannon-Wiener index (H'), which is sensitive

Table 2. Diversity indices like Richeness (S), Shannon-Wiener Index (H'), Evenness (E), and Simpson-diversity Index (D) recorded at various study areas

Statistical measures	Habitat type			
	Woodland	Marshy	Pasture	Caves
S	35.96	21.94	16.54	11.31
H'	3.18	2.37	2.11	2.29
E	0.97	0.94	0.93	0.95
D	0.9 (Low) 1.0 (High)	0.9 (Low) 1.0 (High)	0.9 (Low) 1.0 (High)	0.9 (Low) 1.0 (High)

to changes in the abundance of rare species in a community and Simpson index (D), which is sensitive to changes in the most abundant species in a community. Species richness (S) examines the number of species occurring in a habitat and when all species in a sample are equally abundant an evenness index (E) will be at its maximum. Relatively higher species richness and Shannon index value (S=35.96; H'=3.18) were recorded in woodland having dense plant canopy. In contrast, caves/crevices/rocky areas were found to be sites of lower richness and Shannon index value (S=11.31; H'=2.29) containing fewest distinct species.

A complete record of spider species of the study area summarized as in Table 1 shows that out of 59 families recorded so far in Indian region by Siliwal *et al.* (2005), 16 families were reported from experimental region, representing 27.11% diversity of the total families found in India. Similarly, Singh and Sihag (2007) reported a total of 29 genera of spiders from Jhalana Forest range of Jaipur region and Chauhan *et al.* (2009) observed 39 species of spiders belonging to 29 genera from Jaipur. 25 genera have been reported from distinct habitat sites of Shekhawati Aravalian region of Rajasthan by Saini *et al.* (2012). Likewise, a total of 15 genera of spiders belonging to 9 families were collected and identified from FR Peshawar, Fata, Pakistan by Perveen and Jamal (2012). Similarly, Chetia and Kalita (2012) reported 18 families of spiders representing 56 genera and 95 species in Gibbon Wildlife Sanctuary, Assam, India and More and Sawant (2013) recorded a total of 28 families of spiders belonging to 119 genera and 247 species with a dominance of Araneid, Salticid and Lycosid spiders. Families like Araneidae, Lycosidae and Salticidae exhibited maximum diversity. Because of bright colouration and large orb webs, these spiders were easily recognized. Orb-web building families like Araneidae and Tetragnathidae constituted 27% of total collected spider fauna. Dhali *et al.* (2016) recorded a total of 111 species under 32 genera belonging eight families from 17 states and two union territories.

The results on percent abundance of spider families are similar to that of Poornima (2001) showing Araneidae and Salticidae as most abundant families having 25 and 11% relative abundance, respectively in garden crops of Western Ghats of India. Results of present study are also in accordance with that of Sebastian *et al.* (2005) reported that Araneidae and Tetragnathidae as dominant families and *Tetragnatha mandibulata* (Tetragnathidae) as the most abundant species. Data collected on spider family abundance during the present study were also found positively correlated with the data collected by Sudhikumar *et al.* (2006) on spider family abundance in Mannavan Shola Forest, Kerala, India. They reported 72 species of spiders belonging to 57 genera and 20 families. Araneidae, Tetragnathidae, Salticidae and Thomisidae were found as dominant spider families.

Results of the present study are quite similar to that of Bhat *et al.* (2013), who studied diversity, seasonal abundance and status of spiders in cashew agro-ecosystem, Karnataka. They reported that Salticidae was found as the numerically prominent family, forming 33.65 % of the sample while other families found as Araneidae (22.12), Theridiidae (8.65), Thomisidae (7.69), Oxyopidae (5.77) and Tetragnathidae (5.77), Gnaphosidae (3.85) and Nephilidae (3.85) and Sparassidae (2.88). All other families contributed less than 2% to the overall abundance. Similarly, More (2015) reported the first record of diversity of spiders from Zolambi region of Chandoli National Park in Western Ghats. A total of 90 species belonging to 55 genera and 19 families were recorded from the study area during 2011-2013 with a dominance of Araneid, Salticid and Lycosid spiders. Likewise, Lone *et al.* (2015) also reported Araneidae as dominant family followed by Lycosidae, Linyphiidae, Pholcidae, Salticidae, Sparassidae and Clubionidae in that order.

Bonn and Kleinwächter (1999) suggested that species richness increased with habitat divergence and interrelated sets of species traits. Similarly, Chatzaki *et al.*, (2002) reported taxonomy, ecology and distribution of 22 spider species belonging to the genera *Anagraphis, Poecillochroa, Berinda, Callilepis, Micaria, Pterotricha, Gnaphosa, Nomisia, Haplodrassus* and *Leptodrassus* of the family Gnaphosidae. They suggested that temperature and food availability were the factors responsible for variability in abundance and distribution of spiders. 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, but no species was recorded as indicator species during the present study.

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. Intermediate disturbance hypothesis supported observations made during the present study, where *Hersilia savignyi*, *Telamonia vittata*, *Pardosa sumatrana* and *Oxyopes shweta* were recorded to be protected from disturbance having low D value (D=0.9). In contrast, *Xysticus minutus*, *Plexippus paykullii*, *Araneus bituberculatus* and *Agelena* sp. were found to have undergone intermediate disturbance having high D value (D=1.0). Since species distribution is correlated with factors such as temperature, humidity and distinctive plant growth, during the present study, relatively higher species richness and Shannon index value were recorded in woodland having dense plant canopy. In contrast, caves/crevices/rocky areas were found to be sites of lower richness and Shannon index value containing fewest distinct species. The least number of species recorded in caves/rocky areas can be explained by scarce vegetation as well as by limited space for web building. Thus, it was concluded that spider communities fluctuated in all selected habitat types accordingly with different ecological conditions. Bhat *et al.* (2013) qreported that Salticids were predominant (30%) and Araneidae contributed 22% of the spider fauna with Shannon index, Simpson index, Evenness index and Margalef Richness index evaluated as 4.20, 0.04, 0.50 and 14.73, respectively.

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