SEASONAL ABUNDANCE AND INDICES OF SPIDERS OF YEARS 2013 TO 2016 FROM DIFFERENT HABITATS OF EASTERN REGION OF RAJASTHAN, INDIA

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***ABSTRACT*: Spiders are known for their large number of free economic services in agriculture and in the maintenance of ecosystem balance. The present study dealt with the seasonal abundance and diversity indices of spider fauna in Eastern region of Rajasthan. Spiders from 17 families were recorded from three weather seasons out of 59 families (Keswani 2012) recorded from**
India. This is about 1/3rd of the total families recorded from India. We have Recorded 51 Species under the 40 genera in the study area. In the present study the seasonal abundance was studied. 16 families 35 genera and 43 species were recorded from Monsoon season; 12 families 28 genera and 35 species from Winter season and 13 families 25 genera and 28 species recorded in Summer season. These results indicated that spider's diversity in Eastern
Region of Rajasthan is mostly dependent on the presence of food and paste species in the said area. Due to presence of ample food and paste diversity the Monsoon season represented high diversity of spider in this region. The present study will form baseline for the new approaches in IPM and conservation strategies of Spider fauna.

***Keywords*: Spiders, seasonal abundance, population indices, Eastern region of Rajasthan.**

1. INTRODUCTION

In India the conservation efforts have focused on higher vertebrates and invertebrates have largely been ignored. The Arachnids are one such important group. Sspider can regulate large population of insect and other invertebrate in most ecosystems (Russell-Smith, 1999).

Therefore, there is a growing need to study this group. Spiders belong to order Araneae of class Arachnida (Latin arānea means spider). They are exclusively predator, with body divisible in two parts, prosoma or cephalothorax and abdomen or opisthosoma. They have eight legs attached to the cephalothorax. They possess varied distributions both in habitat, depending upon their site suitability and feeding behaviour, they are found in almost all types of ecosystems. There are mainly two major groups of spiders: old day spiders i.e.

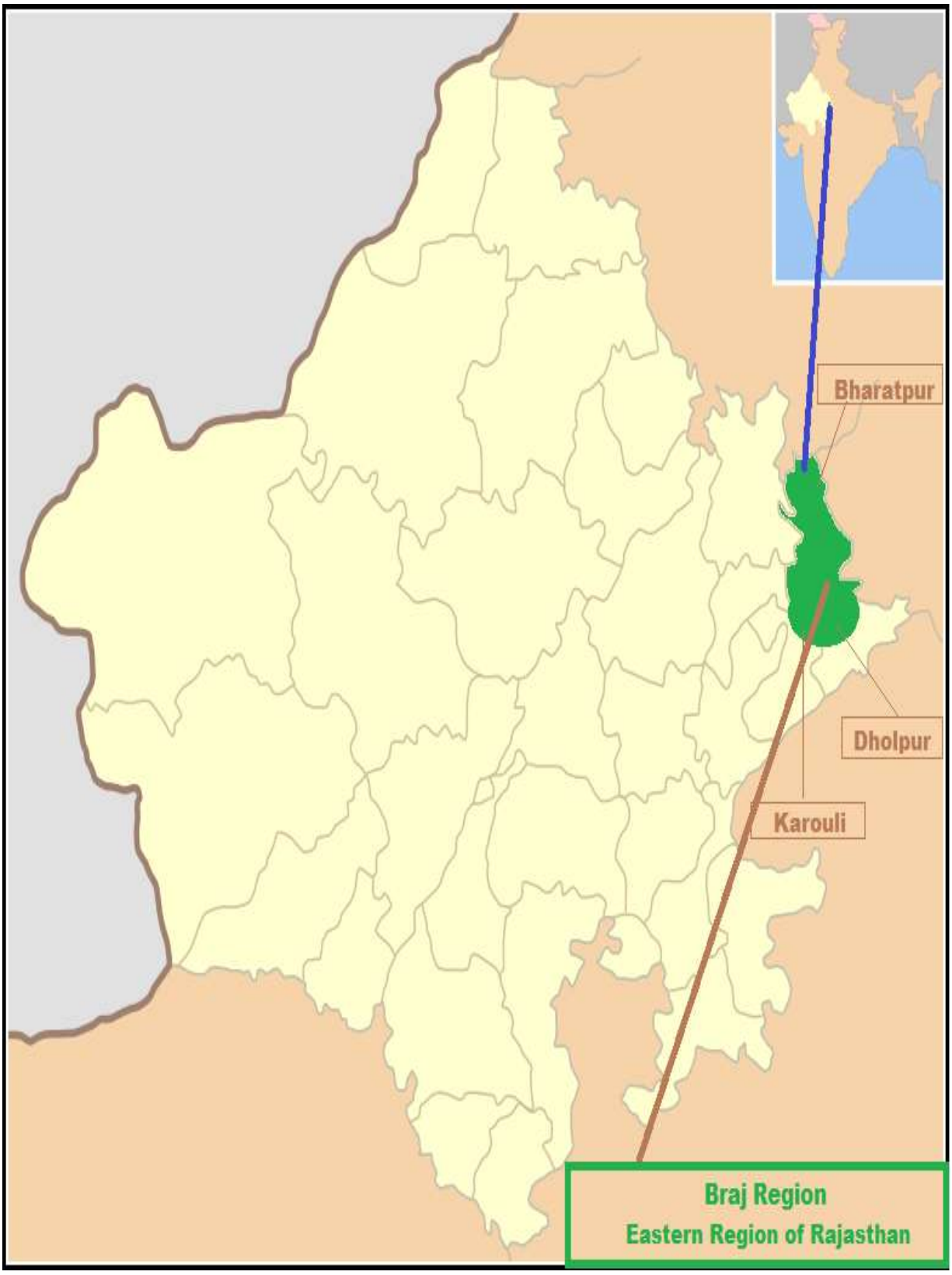
Mygalomorphs and present day spiders i.e. Araneomorphs. Tikader (1987) published the first list of Indian spiders reporting 1067 spider species from 249 genera and 43 families. Siliwal et. al. (2005) published a paper on checklist of Indian spiders with 1442 species from 361 genera and 59 families are reported. Keswani et. al. (2012) published the check list of spider from India Mentioning 1686 Species from 438 genera and 60 families. Ritu (2012) recorded 32 species under 12 families from Shekhawati region in Rajasthan. Anjali and Santprakash

(2012) recorded 34 species under 12 families from Agra. Recently Lawania et. al. (2013) recorded 24 species from 10 families under the 16 genera. Lawania et. al. (2013) listed 75 species of spiders belonging to 17 families under the 45 genera. Lawania (2013) also studied on web pattern and architecture in some spider from central India and recorded 6 types of web pattern in this area. Kaur et. al. (2014) published 30 species belonging to 26 genera and 11 families. Eastern area of Rajasthan with its varied geographic, climatic, and ecological features exhibits a rich assemblage of different types of spiders' species. However, no studies on their diversity indices and seasonal abundance have ever been undertaken here; with the result that many of the spider species still remain unnamed and unrecorded. Some studies taken by Lawania 2013(a,b,c,d,e,f). During the recent faunal studies in Eastern region of

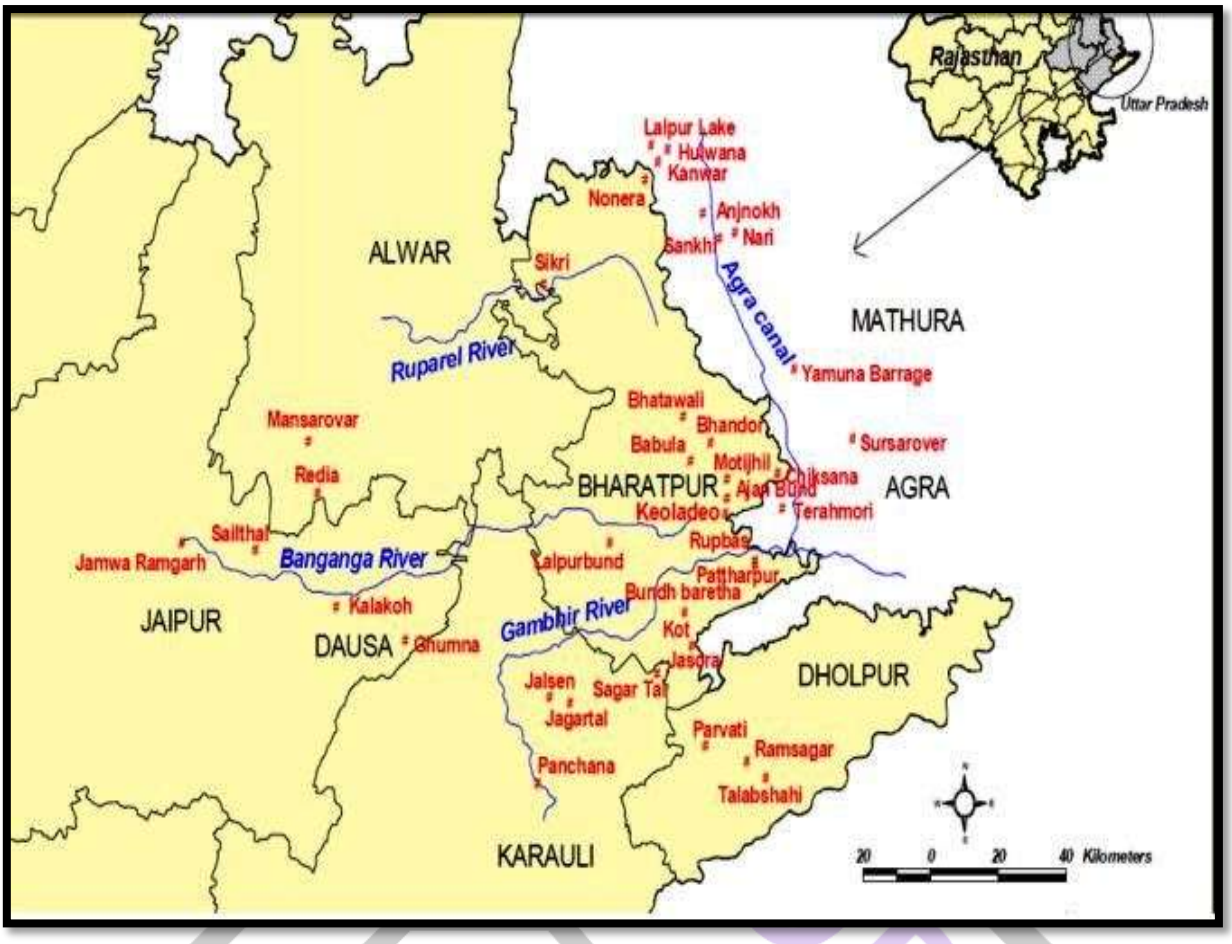
Rajasthan, authors could collect an interesting specimen of spiders, which are not described earlier from study area. Further, environmental pollution and deforestation have led many spider species to the verge of extinction. Hence the present work is conducted with a goal tofind the objectives envisaged in the proposal mentioned below.

2. MATERIAL AND METHODS

2.1 Study area- The present work has been carried out in forest and agriculture fields of Eastern region of Rajasthan (India). The Eastern region of Rajasthan (Map-1) covers mainly Bharatpur district and some micro habitat areas of Dholpur and Karoli district (27.2170°N 77.4895°E) in Rajasthan. It was earlier known as "Braj". This dense forest region has wide diversity of habitats ranging from marshes, grasslands, woodlands, scrublands. South-West monsoon brings rainfall during the month of June to September. The average monthly temperature is 4 ^{O} C in December and 42 ^{O} C in June. The humidity in winter season is as low as 42% in the month of February and as high as 89% in the month of August. Eastern Region of Rajasthan lies at the confluence of the Gambhir and Banganga rivers. The area lies between 27°2170 North Latitude and 77° 4895 East Longitude. It is a low lying area in the floodplains of river Banganga and Gambhir which are tributaries of river Yamuna covering an area of about 5099 sq. km. It is situated 180 km from Delhi, along the Delhi – Jaipur Highway, 50 km from Agra.



Map – 1- Location Map of Eastern region of Rajasthan



Map – 2- High value biodiversity areas (HVBA) of Eastern region of Rajasthan

2.2 Approaches

Macro level approach- Details of the research works undertaken in and around Eastern Region of Rajasthan was collected; Efforts were made to collect the available information from the following sources:
Newspaper reports/articles, Research articles published in scientific journals, Research reports and dissertations from academic and research institutions, Information available online, Records from various line departments of Government of Rajasthan, Government of India and other relevant sources such as Department of Forest and Wildlife, Agriculture, Irrigation, Rural Development, State Pollution Control, Board, Directorate of Economics and Statistics, State Ground Water Board, and Regional Census Office, Jaipur, India Meteorology Department (IMD), Jaipur. The collected information were collated and sorted out into a temporal scale of 5 years and as appropriate based on the availability of datasets to analyze the annual/decadal changes
Micro level approach- To gain basic understanding about the perception and opinion about ground scenario and the changes occurring over time, discussions were held with stakeholders.
Following approaches were adopted: Customized questionnaire survey and interaction with naturalists, armature bird watcher and Arachnologists.

2.3 Methods of collection (Especially spiders)

In total 24 study sites were chosen. Spiders were collected and counted by the two quantitative methods viz- Transect method (50 m x 10 m transects, with two transects per site) and quadrate method (20 m x 10 m quadrate, with 5-5 quadrate in per site and 10-10 quadrates in 15th & 16th sites.

(a) Field Methods: Well standard sampling protocols were adopted for spider collection in different sites of sampling. The detailed descriptions of this collection techniques are-

(i) Sweep Netting- this method is used to collect the foliage spiders is collated by this sampling method from herbs shrubs and low level vegetation (up to 2 m in height). The sweep net consists of a 90 cm handle; 40 cm ring.

(ii) Ground Hand Collecting- Knee level spider samples collected from this collection method. This method of sampling is used to collect the spiders, in the ground, litter, in broken logs, rocks which are found to be visible.

(iii) Aerial Hand Collecting- This collection method involved the collection of species of spiders from knee level to arm length level. This method accessed free-living and web-building spiders on the stems of living or dead shrubs, high herbs, foliage and tree trunks etc.

(iv)Vegetation Beating- This method is used to accesses spiders living in the shrub, high herb vegetation, bushes, branches and small trees. In this method spiders were collected on a cloth (1 m by 1.2 m) by beating high herbs vegetation, dead shrubs and high herbs with a stick.

(v) Litter sampling- Specimen were collected by hand. Litter sampling involved sorting of spiders from the litter collection tray.

(vi) Pitfall sampling- Wet pitfall trap method was used to study the ground dwelling spiders. The pitfall traps consisted of a 9 cm wide by 16 cm deep plastic jar, two-third filled with 70% ethyl alcohol and a few drops of liquid soap/detergent. The pitfall traps were left open for a period of three days. The distance between two adjacent jars was 5 meter.

3. RESULT AND DISCUSSION

The study was performed on 24 study sites of the said region. Spiders were collected and counted by most of the two quantitative methods viz- Transect method (with two transects per site and 50 m x 10 m transects,) and quadrate method (20 m x 10 m quadrates, with 5-5 quadrate per site and 10-10 quadrates in 15th & 16th site. These transect and quadrates were treated as our basic sampling units. Transects and quadrates were placed randomly within stratified habitat types. Sampling was carried out between July 2013 – Dec.2016. Spiders were sampled along these transects and quadrates using six sampling techniques (semi quantitative sampling and pitfall traps). The main purpose of this sampling design was to produce a relatively complete species list and associated abundance data for a representative example of each habitat type in the region, and of the region as a whole.

Table-1- Seasonal abundance and population indices of spiders (*Randomly search method, Quadrate method, line-transect method and other methods were used for searching and collection*) in monsoon, winter, summer seasons 2013- 2016 from different habitats in Eastern Region of Rajasthan.

Family	Species (F- Female & M- Male)	Habits	Habitats	Total Season wise abundance of spider species in 2013-2016 from Eastern Region of Rajasthan			Total sp. count	Mean ± S.E
				Monsoon	Winter	Summer		
Araneidae	1. *Araneus sp.* F	Web builder	Woodland	9	18	-	27	**9.0± 5.19**
	2. *Argiope aemula* F	Web builder	Woodland	42	65	12	119	**39.66± 15.34**
	3. *Cyclosa moonduensis* F	Web builder	Woodland	28	31	19	78	**26.0± 3.60**
	4. *Cyclosa moonduensis* M	Web builder	Woodland	9	20	5	34	**11.33± 4.48**
	5. *Cyrtophora cicatrosa* F	Web builder	Woodland& Grassland	34	37	11	82	**27.33± 8.21**
	6. *Cyrtophora citricola* F	Web builder	Woodland& Grassland	33	39	21	93	**31.0± 5.29**
	7. *Eriovixia excelsa* F	Web builder	Woodland	-	23	-	23	**7.66± 7.66**
	8. *Larinia chloris* F	Web builder	Woodland& Grassland	40	33	20	93	**31.0± 5.85**
	9. *Larinia chloris* M	Web builder	Woodland	10	17	10	37	**12.33± 2.33**
	10. *Neoscona mukerjei* F	Web builder	Woodland	34	27	-	61	**20.33± 10.36**
	11. *Neoscona crucifera* F	Web builder	Woodland	-	19	-	19	**6.33± 6.33**
	12. *Neoscona nautica* F	Web builder	Woodland	-	15	-	15	**5.0± 5.0**
	13. *Neoscona theisi* F	Web builder	Woodland	38	44	21	103	**34.33± 6.88**
	14. *Zyngeilla indica* F	Web builder	Woodland	23	20	-	43	**14.33± 7.21**
Clubionidae	15. *Clubiona*	Hunting	Grassland& Wetland	19	-	34	53	**17.66±**

	filicata F	spider						**9.83**
Filistatidae	16. *Pritha sp.* M	Web builder	Woodland& Grassland	11	-	-	11	**3.66± 3.66**
Gnaphosidae	17. *Drassodes luridus* F	Hunting spider	Grassland	21	8	27	56	**18.66± 5.60**
	18. *Zelotes shantae* F	Hunting spider	Grassland	12	-	-	12	**4.0± 4.0**
Hersilidae	19. *Hersillia savingyi* F	Hunting spider	Grassland& Wetland	6	15	-	21	**7.0± 4.35**
Lycosidae	20. *Pardosa peudoannulata* F	Hunting spider	Grassland& Wetland	23	8	19	40	**16.66± 4.48**
	21. *Pardosa peudoannulata* M	Hunting spider	Grassland& Wetland	9	4	14	27	**9.0± 2.88**
	22. *Wadicosa fidelis* F	Hunting spider	Grassland& Wetland	16	-	-	16	**5.33± 5.33**
Oxyopidae	23. *Oxyopes biramanicus* F	Hunting spider	Grassland & Woodland	44	31	26	101	**36.66± 5.36**
	24. *Oxyopes ck. kohensis* F	Hunting spider	Grassland & Woodland	12	24	-	36	**12.0± 6.92**
	25. *Oxyopes pankaji* F	Hunting spider	Grassland & Woodland	47	43	32	122	**40.66± 4.48**
	26. *Oxyopes pankaji* M	Hunting spider	Grassland & Woodland	13	10	-	23	**7.66± 3.92**
	27. *Oxyopes sp.* F	Hunting spider	Grassland & Woodland	6	-	-	6	**2.0± 2.0**
Pholcidae	28. *Artema atlanta* F	Web builder	Woodland	36	38	30	104	**34.66± 2.40**
	29. *Crossopryza lyoni* F	Web builder	Woodland	27	34	31	92	**30.66± 2.02**
	30. *Pholcus phalangiodes* F	Web builder	Woodland	22	20	-	42	**14.0± 7.02**
Pisauridae	31. *Hygropoda sp.* F	Hunting spider	Grassland & Wetland	6	-	-	6	**2.0± 2.0**
	32. *Nilus albocinctus* F	Hunting spider	Grassland & Wetland	23	32	14	69	**23.0± 5.19**
Salticidae	33. *Hyllus semicupreus* F	Hunting spider	Grassland & Woodland	45	-	27	72	**24.0± 13.07**
	34. *Menemerus bivittatus* F	Hunting spider	Grassland & Woodland	27	11	31	69	**23.0± 6.11**
	35. *Menemerus bivittatus* M	Hunting spider	Grassland & Woodland	12	8	19	39	**13.0± 3.21**
	36. *Myrmarachne sp.* F	Hunting spider	Grassland & Woodland	28	-	27	55	**18.33± 9.17**
	37. *Phintella vittata* F	Hunting spider	Grassland & Woodland	44	-	32	76	**25.33± 13.13**
	38. *Phintella vittata* M	Hunting spider	Grassland & Woodland	20	-	13	33	**11.0± 5.85**
	39. *Plexippus paykulli* F	Hunting spider	Grassland & Woodland	80	41	45	166	**55.33± 12.38**
	40. *Plexippus paykulli* M	Hunting spider	Grassland & Woodland	33	21	29	83	**27.66± 3.52**
	41. *Plexippus petersi* F	Hunting spider	Grassland & Woodland	24	35	28	87	**29.0± 3.21**
	42. *Telamonia dimidiata* F	Hunting spider	Grassland & Woodland	39	38	33	110	**36.66± 1.85**
	43. *Telamonia dimidiata* M	Hunting spider	Grassland & Woodland	18	15	17	50	**16.66± 0.88**

	44. *Thyene imperialis* F	Hunting spider	Grassland & Woodland	26	26	31	83	**27.66± 1.66**
Scytodidae	45. *Scytodes fusca* F	Hunting spider	Grassland & Woodland	11	-	-	11	**3.66± 3.66**
	46. *Scytodes thoracica* F	Hunting spider	Grassland & Woodland	13	-	-	13	**4.33± 4.33**
Selenophidae	47. *Selenopes insularis* F	Hunting spider	Grassland & Woodland	21	-	32	53	**17.66± 9.38**
Sparassidae	48. *Olios milleti* F	Hunting spider	Grassland & Woodland	31	-	12	43	**14.33± 9.02**
	49. *Olios obesulus* F	Hunting spider	Grassland & Woodland	25	-	-	25	**8.33± 8.33**
Tetragnathidae	50. *Guizygiella melanocrania* F	Web builder	Woodland	-	40	-	40	**13.33± 13.33**
	51. *Leucauge decorata* F	Web builder	Woodland	-	61	8	69	**23.0± 19.13**
	52. *Tetragnatha sp.* F	Web builder	Woodland	-	27	4	31	**10.33± 8.41**
Theridiidae	53. *Tylorida ventralis* F	Web builder	Woodland	21	23	-	44	**14.66± 7.35**
Thomisidae	54. *Misumenops celer* F	Hunting spider	Grassland & Woodland	32	32	-	64	**21.33± 10.66**
	55. *Philodromus sp.* F	Hunting spider	Grassland & Woodland	34	24	18	76	**25.33± 4.66**
	56. *Tmarus sp.* M	Hunting spider	Grassland & Woodland	7	-	-	7	**2.33± 2.33**
Uloboridae	57. *Uloborus plumipes* F	Web builder	Woodland	32	30	15	77	**25.66± 5.36**
	58. *Uloborus sp.* F	Web builder	Woodland	-	22	-	22	**7.33± 7.33**
	59. *Zosis genuculata* M	Web builder	Woodland	28	-	-	28	**9.33± 9.33**
Total	**Specimen- 59 Family- 17 Genus- 40 Species- 51 Female- 48 Male- 11**	**Dominance of sp. Habits- Hunt. spider >Web builder**	**Dominance of habitat- Woodland>Grassland > Wetland**	**1304**	**1140**	**767**	**3211**	
				Dominance of season- Monsoon> Winter> Summer				

Dominance of family-

Araneidae > Salticidae > Oxyopidae > Lycosidae ≈ Pholcidae ≈ Tetragnathidae ≈ Thomisidae ≈ Uloboridae > Gnaphosidae≈ Pisauridae ≈ Scytodidae ≈ Sparassidae > Clubionidae ≈ Filistatidae ≈ Hersilidae ≈ Selenophidae ≈ Theridiidae

Three dominant species- *Plexippus paykulli* F > *Oxyopes pankaji* F > *Argiope aemula*

Three rare species- *Oxyopes sp.* F < *Tmarus sp.* M < *Scytodes fusca* F

In the present study the seasonal abundance of spiders was studied. 16 families 35 genera and 43 species were recorded in Monsoon season; 12 families 28 genera and 35 species in Winter season and 13 families, 25 genera and 28 species recorded in Summer season. These results indicated that spider's diversity in Eastern Region of Rajasthan is mostly dependant on the presence of food and pest species in the said area. Due to presence of ample food and pest diversity the Monsoon season represented high diversity of spider in this region. In the present investigation, the important observation is hunters or and ground dweller spiders dominated the study area over the web builders irrespective of the said area. This could possibly be due to the agricultural practices used in different crop fields. During the crop season, workers work in the field and their movements disturb the webs. Therefore, only those web constructing spiders were reported, which could construct their webs in a limited space and secondly most of them are nocturnal. During evening, they construct the web, prey whole night on the pests caught in the web and by dawn, they eat their webs (*Neoscona*).

Among web builder, *Argiope* and *Cyclosa* dominated all the three seasons. Cyclosa is thus the most successful web builder as they require a small space to construct mostly the basal webs.

We have recorded some observations about their feeding habits. Jumping spiders are found to rely much more on sight. Web builders from some families like Araneidae, Pholsidae and Tetragnathidae have advantages of catching prey in the web. Ground spiders like Saltisids, Oxyopids, Gnaphosids and Lycosids adapt the technique of watching, catching, grabbing their prey. It is most interesting to note that spiders from Pisauridae family prey on aquatic larvae as well as adult insects. All the observations indicated that they are keeping the insect population in control and thus helping human being from getting protected from vector borne diseases.

These observations indicate that the spiders survive in very specific habitats avoiding competition among them. The microhabitats used by spider were noted, during survey and collection of spiders. The detail observations of each spider collected are categorically; three types of major microhabitats were observed, on the plant / branches, in the web and on the ground. Some of them were found on ground under litter, some on shrubs, trees, tall trees, on the webs between adjacent shrubs and trees.

Among web builders also, webs were found to be constructed between plant and ground (basal), between branches and adjacent plants (foliar) and on the ground (epigeal).

Hunting spiders were seen using microhabitats like crevices in the ground, litter and mulch on the ground, on the ground surface, foliage, on the plants and pseudo-stems, dried leaves etc.

Calculation of Alpha & Beta diversity and Diversity indices- Species richness was estimated in each Season. Similarity of spider species among different seasons was examined using the diversity indices including, Simpson index, Shannon – weiner index and Margalef richness index. The diversity, richness, and evenness indices for spiders were calculated using the Biodiversity calculator (www. Alyoung.com/labs/biodiversity calculator_html).

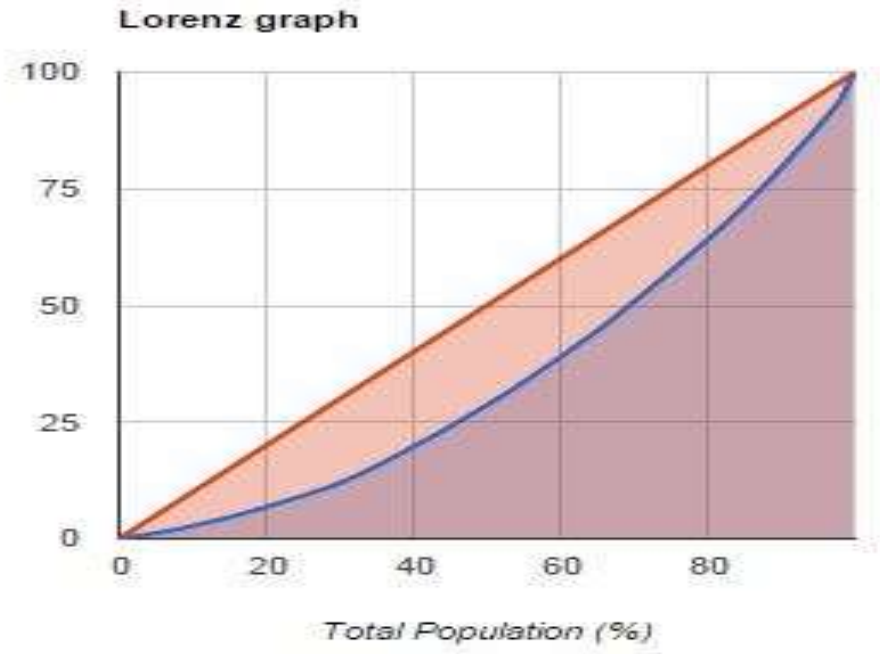
Table-2- Representing diversity indices of spiders in the all seasons (Monsoon, Winter and Summer) of the years of 2013-2016 in Eastern Region of Rajasthan

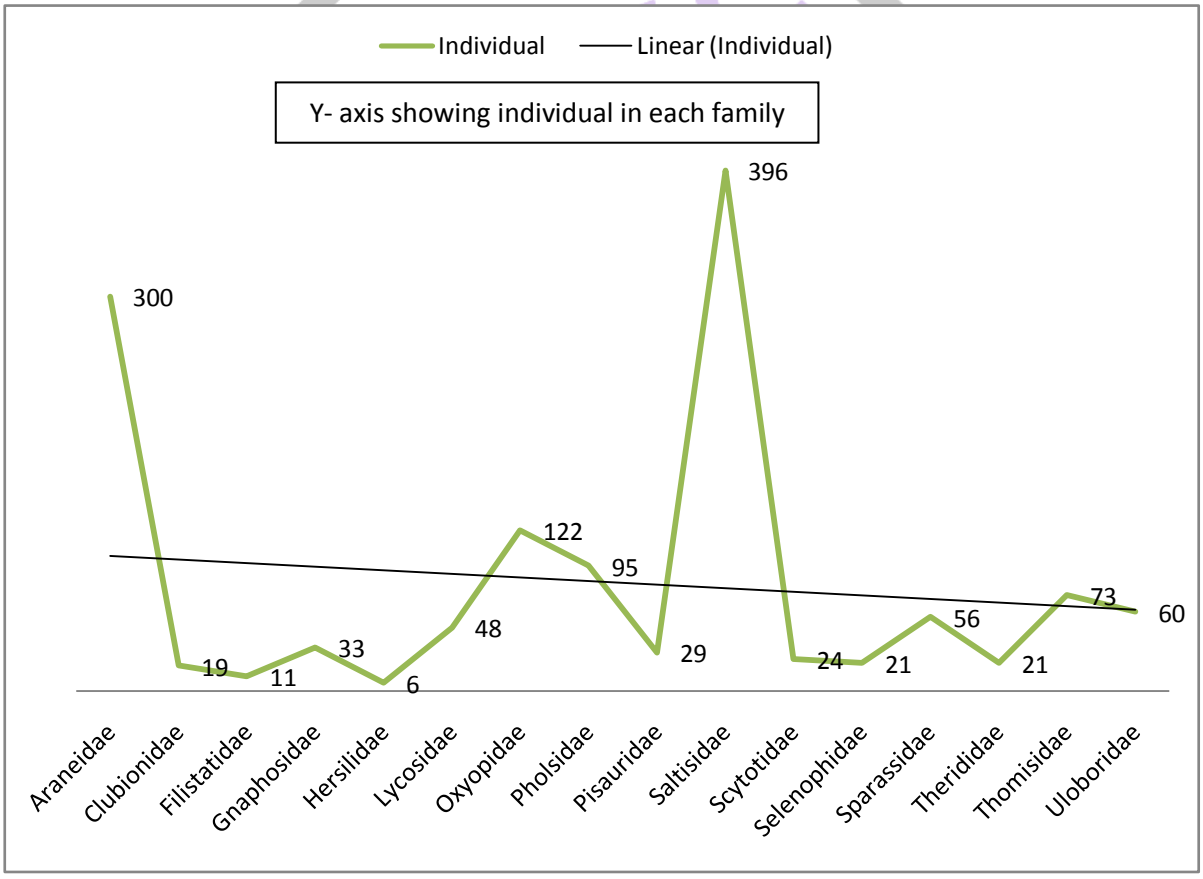
Diversity Indices	Formula for calculation	Diversity indices of spiders in Eastern Region of Rajasthan			
		Monsoon	Winter	Summer	Combined biodiversity of (M,W & S)
Alpha Biodiversity of spiders					
Total no. of spider	-	**1304**	**1139**	**767**	**3190**
Total no. of species	-	**52**	**42**	**35**	**59**
Average population size	-	**25.08**	**27.12**	**21.91**	**54.07**
Simpson Index	$\frac{\sum_i n_i(n_i-1)}{N(N-1)}$	**0.02438**	**0.02868**	**0.03272**	**0.02364**
Simpson Index Approximation	$\frac{\sum_i n_i^2}{N^2}$	**0.02512**	**0.02954**	**0.03398**	**0.02394**
Reciprocal Simpson Index	$\frac{1}{\left(\frac{\sum_i n_i^2}{N^2}\right)}$	**41.03**	**34.86**	**30.56**	**42.31**
Alternate Reciprocal Simpson Index	$\frac{1}{\left(\frac{\sum_i n_i(n_i-1)}{N(N-1)}\right)}$	39.8	33.86	29.43	41.77
Dominance index	$1-\left(\frac{\sum_i n_i(n_i-1)}{N(N-1)}\right)$	0.9756	0.9713	0.9673	0.9764
Dominance index Approximation	$1-\left(\frac{\sum_i n_i^2}{N^2}\right)$	**0.9749**	**0.9705**	**0.966**	**0.9761**
Shannon Index	$-\sum_i\left(\frac{n_i}{N}\cdot\log_2\left(\frac{n_i}{N}\right)\right)$	**5.487**	**5.216**	**4.982**	**5.581**
Shannon Index	$-\sum_i\left(\frac{n_i}{N}\cdot\ln\left(\frac{n_i}{N}\right)\right)$	**3.804**	**3.615**	**3.453**	**3.869**
Shannon Index	$\sum_i\left(\frac{n_i}{N}\cdot\log_{10}\left(\frac{n_i}{N}\right)\right)$	**-1.652**	**-1.57**	**-1.50**	**-1.68**
Berger-Parker Dominance	$\frac{n_{max}}{N}$	**0.06135**	**0.05707**	**0.05867**	**0.05204**
Inverted Berger-Parker Dominance Index	$\frac{N}{n_{max}}$	16.3	17.52	17.04	19.22
Margalef Richness Index	$\frac{S-1}{\ln N}$	**7.11**	**5.826**	**5.119**	**7.189**

Menhinick Index	$\frac{S}{\sqrt{\sum_i n_i}}$	1.44	1.244	1.264	1.045
Renyi Entropy/ Hill Numbers (r=0,1,2,∞)	$\frac{1}{1-r}\cdot\ln\left(\sum_i p_i^r\right)$	52, 44.87, 39.8, ≈∞	42, 37.18, 33.86, ≈∞	35, 31.6, 29.43, ≈∞	59, 47.91, 41.77, ≈∞
In ( ) of Hill Numbers (0,1,2,∞)	-	3.951, 3.804, 3.684, ≈ - ∞	3.738, 3.616, 3.522, ≈ - ∞	3.555, 3.453, 3.382, ≈ - ∞	4.078, 3.869, 3.732, ≈ - ∞
Buzas and Gibson's Index	$\frac{e^{-\sum_i\left(\frac{n_i}{N}\cdot\ln\left(\frac{n_i}{N}\right)\right)}}{S}$	0.8627	0.885	0.9028	0.8116
Gini Coeffificient	-	26.05	21.58	18.47	27.75
Equitability Index	$-\frac{\sum_i\left(\frac{n_i}{N}\cdot\ln\left(\frac{n_i}{N}\right)\right)}{\ln N}$	0.9626	0.9673	0.9712	0.9488
Beta Biodiversity of spiders					
Absolute Beta Value	$((S_0\text{-}c)\text{-}(S_1\text{-}c)\ldots)$	51	41	34	58
Whittaker's Index	(S/alpha)	1	1	1	1
Alternate Whittaker's Index	Index (S/alpha-1)	0	0	0	0
Sorensen's Similarity Index	-	1	1	1	1
Sorensen's Similarity Index (%)	-	100%	100%	100%	100%
Jaccard Index	-	-1	-1	-1	1
Jaccard Index (%)	-	-100%	-100%	-100%	-100%
Routledge beta-R Index	-	17.33	14	11.67	19.67
Mountford Index	-	-0.04	-0.05	-006061	-0.03509
Mountford Index (%)	-	-4%	-5%	-6.061%	-3.509%
Bray Curtis Dissimilarity	-	0	0	0	0
Number of Common species	-	52	42	35	59
Gamma Biodiversity of spiders					
Absolute gamma	$(S_0+S_1\ldots\text{-}c)$	0	0	0	0

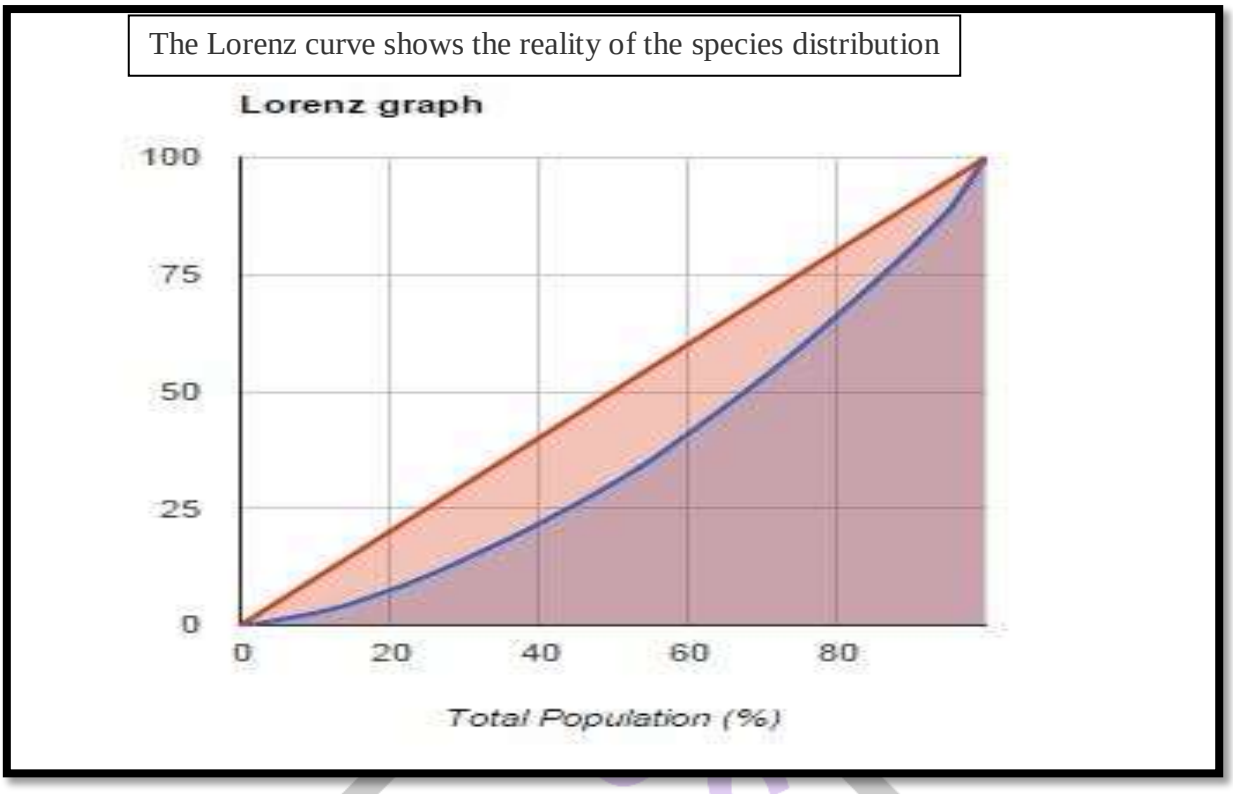
Diversity indices were calculated and are shown in table-10. The dominance index (1-Simpson index) calculated for Monsoon season is 0.9756 and the Shannon index as 5.487. The Shannon indices calculated for Winter and Summer season were 5.216 and 4.982 respectively. The dominance index also calculated for Winter and Summer season for 0.9713 and 0.9673. The Simpson were calculated for all the seasons 0.02438 (monsoon), 0.02868 (Winter) and 0.03272 for Summer. Margalef richness index is the highest (7.11) for spider diversity in Monsoon season. The Margalef richness indices are in the order Monsoon season (7.11) > Winter season (5.826) > Summer season (5.119).

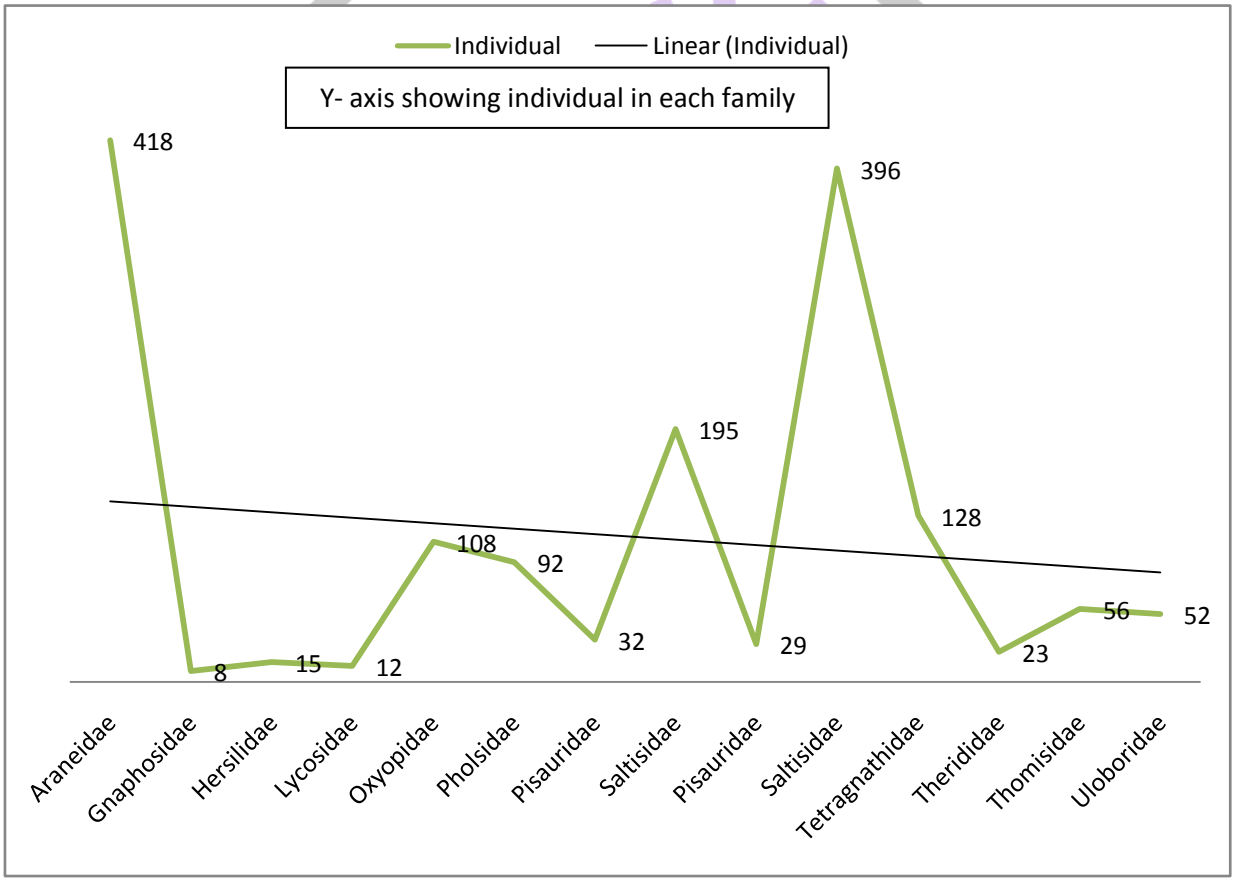
The Lorenz curve shows the reality of the species distribution



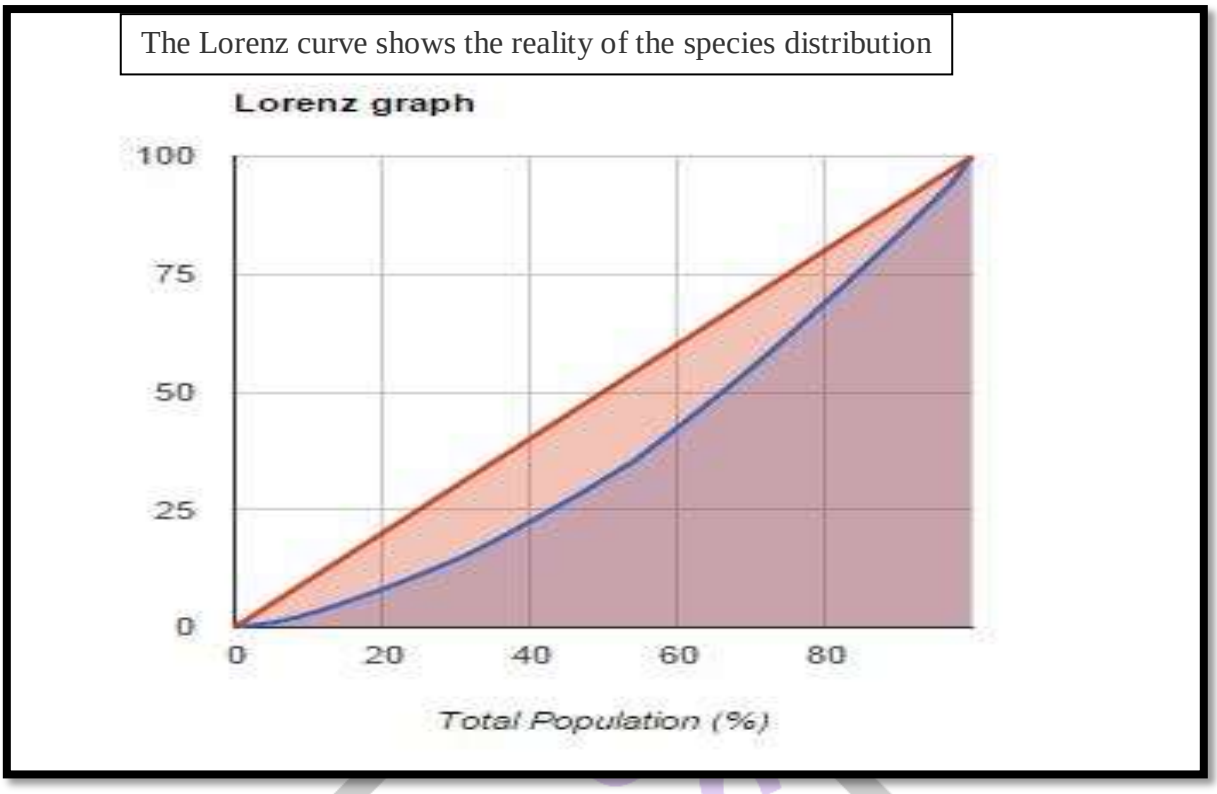


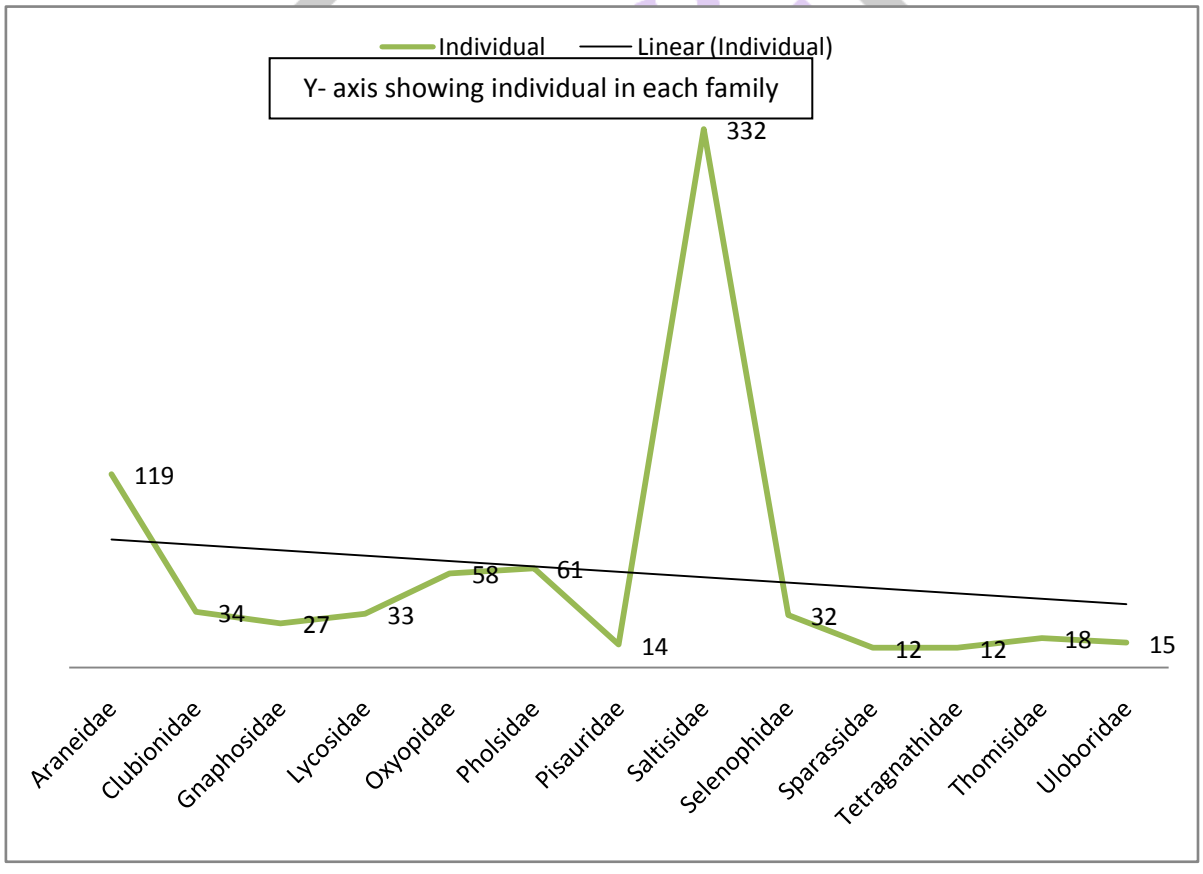
Graph 5&6- Lorenz and linear graph showing diversity richness in Monsoon season in the year 2013-2016
Note- Lorenz graph representing cumulative % population of Spiders



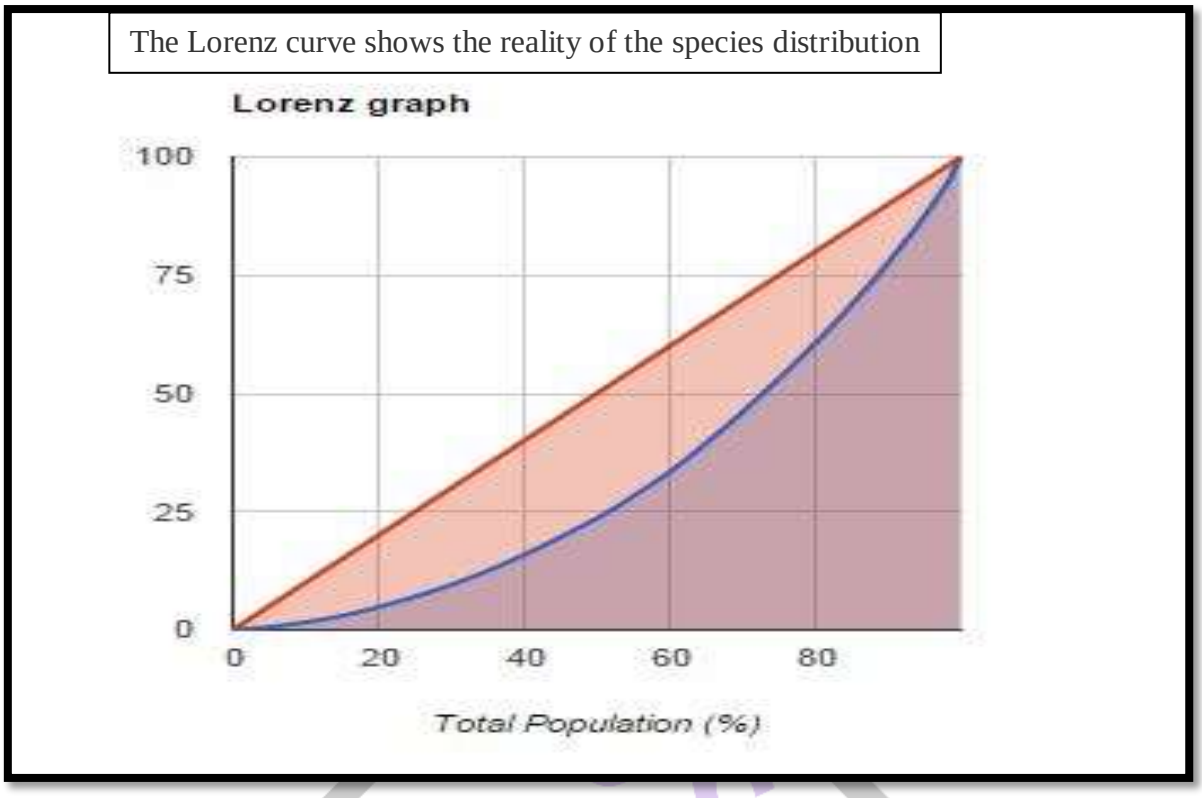


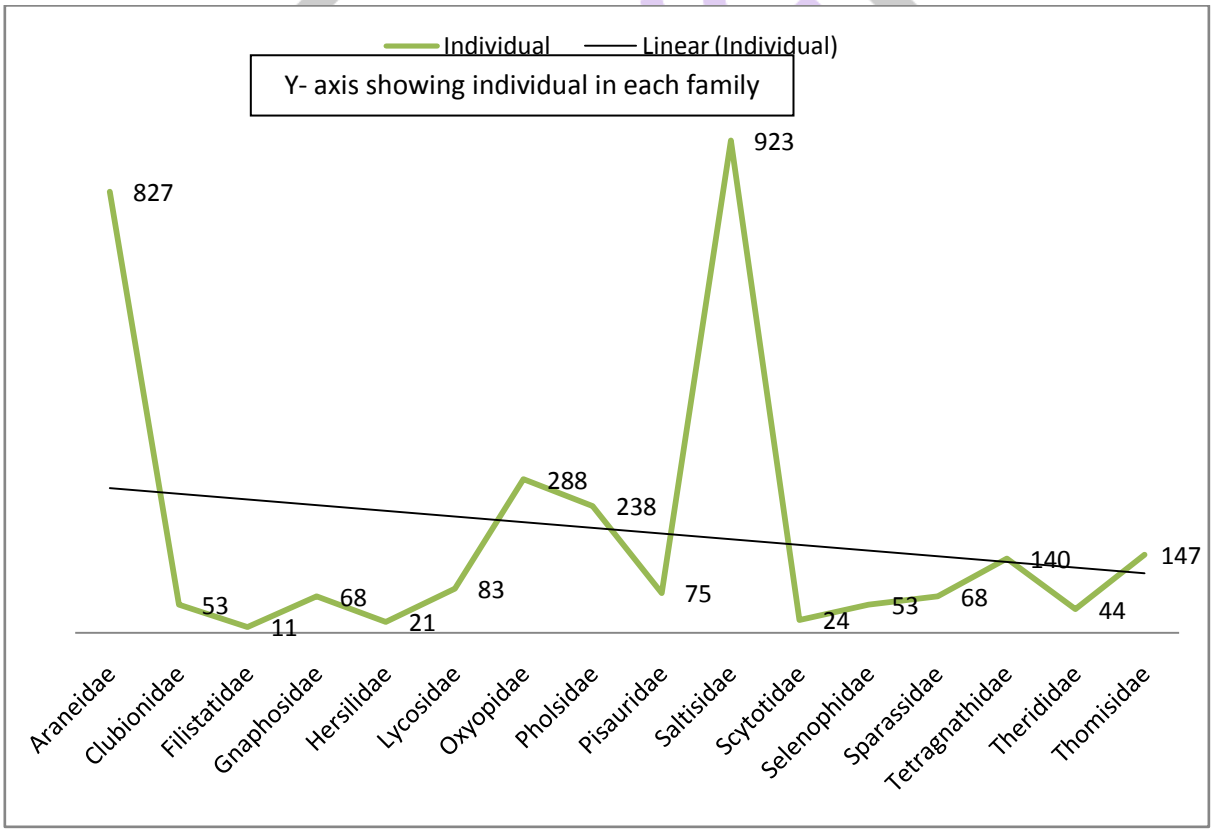
Graph 7&8- Lorenz and linear graph showing diversity richness in Winter season in the year 2013-2016
Note- Lorenz graph representing cumulative % population of Spiders





Graph 9&10- Lorenz and linear graph showing diversity richness in Summer season in the year 2013-2016
Note- Lorenz graph representing cumulative % population of Spiders





Graph 11&12- Lorenz and linear graph showing diversity richness in all (Monsoon, winter, summer) seasons in the year 2013-2016
Note- Lorenz graph representing cumulative % population of Spiders

Habitats of Eastern region of Rajasthan (India) in season Monsoon, Winter and Summer, were surveyed during July 2013 to December 2016. During the present investigation we have listed 17 families and 51 species under the 40 genera from selected habitats. Spiders were collected by using visual search and pitfall trap methods, beating and sweeping methods were also used.

Among all the species collected from all the habitats hunters / ground dwellers dominated to web builders. The relative abundance of spiders in the collection was in the order of – Araneidae > Saltisidae > Oxyopidae > Lycosidae ≈ Pholsidae ≈ Tetragnathidae ≈ Thomisidae ≈ Uloboridae > Gnaphosidae≈ Pisauridae ≈ Scytotidae ≈ Sparassidae > Clubionidae ≈ Filistatidae ≈ Hersilidae ≈ Selenophidae ≈ Theridiidae. Out of the 17 families recorded from the three seasons, spider from Araneidae, Lycosidae, Satisidae, Thomisidae,
Sparassidae and Tetragnathidae are dominant and together from more than 80 % of the predator population preying on the pests. At the species level *Plexxipus payankulli* and*Oxyopes pankaji* was most common spider species observe in all the season from study area.
In the present investigation, the important observation is hunters or and ground dweller spiders dominated the study area over the web builders irrespective of the said area. It is also observed that the web builders like *Argiope* and *Uloborus* in particular change their habitat throughout the year as they grow. During their juvenile stages spiders construct their webs in the vegetation at different heights, but once they reach adult they get stabilized at a particular height in the same vegetation.

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