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Diversity of Spiders in Paddy Ecosystem of Middle Gujarat

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ABSTRACT: Spiders play a significant role in agro-ecosystem as predators. The knowledge on the diversity and abundance of spider species in crucial in developing ecologically sound pest management strategies. A study was carried out to document the diversity of spiders in paddy growing area of middle Gujarat. Tarapur (Lat. 22.4877806 & Long. 72.6582336) area of Anand district of Gujarat was selected for the survey during the year 2017-18, 2018-19 and 2019-20. Periodical surveys were conducted for the collection of spiders from paddy ecosystem. The different indices *viz*., species richness, species diversity and species evenness were calculated. The family Araneidae was observed to be the dominant one with maximum number of species- four species (44.44%), five species (71.43%) and seven species (43.75%) in the year 2017-18, 2018-19 and 2019-20 respectively. The *Agriope* sp. and *Neoscona theisi* were found to be the dominant species during the study period. The highest Simpson's diversity index (D) – 0.77and Shannon-Weiner index diversity (H') – 1.83 was documented in the year 2019-20. The data pertaining to species evenness or equitability (E) reveals the low-medium spider diversity in paddy ecosystem of middle Gujarat region.

Keywords: spider, diversity, paddy, araneidae, species richness.

INTRODUCTION

In developing countries, rice is the major staple food crop. Asia alone accounts for more than 90% of the world's rice production and consumption. The crop is known to attack by various insect and non-insect pests during its different growth stages. Spiders form an integral part of the global biodiversity and play a crucial role in ecosystems as terrestrial predators and source of food for other creatures (Sharma *et al.*, 2010). Spiders are one of the most widely recognized groups of arthropods and fascinating invertebrate animals in the world. They have adapted to all ecological environments except air and open sea colonization and distributed worldwide on every continent except Antarctica. According to the World Spider Catalogue (2018), 47761 species of spiders belonging to 4101 genera under 118 families are known from the world. In numbers, 1686 species of 438 genera belongs to 60 families are recorded from India (Keswani *et al.*, 2012). In Gujarat, Yadav *et al.*, (2017) recorded different spider species belonging to 169 genera of 40 families.

Rani and Hima (2018) in Kottayam, Kerala reported Tetragnathidae and Salticidae as dominant spider families where as Araneidae was found to be next dominant family in paddy crop. Jalajakshi and Usha (2019) Turahalli forest, Karnataka reported that Araneidae is the most dominant family with five species- 27.7%, while other families Nephilidae, Salticidae, and Oxyopidae revealed only two species each (11.11%). Bhandarkar and Paliwal (2019) in Navegaon National Park, Maharashtra, documented high diversity in the family Salticidae (6 species), Araneidae (3 species) and Sparassidae (3 species). Rajeevan *et al.*, (2019) Wayanad, Kerala reported the dominant family Salticidae constituting 44 species under 19 genera, followed by Araneidae (22 species).

Spiders act as key biological control agents by feeding on insects like ants, bugs and mites and are considered to be of economic value to farmers as they play important role by consuming wide variety of insects in paddy ecosystem without any damage to crops. In middle Gujarat region, Tarapur taluka of Anand district has sizeable area of paddy cultivation. Under the research programme of All India Co-ordinated Research Project on Biological Control of Crop Pests, an attempt has been made to catalogue the diversity of spiders in Tarapur area of Anand district in the year 2017-18, 2018-19 and 2019-20.

MATERIALS AND METHODS

Study site: Tarapur (Lat. 22.4877806 & Long. 72.6582336) area of Anand district of Gujarat was selected to study the diversity of spiders. Surveys were carried out during *Kharif* season of 2017-18, 2018-19 and 2019-20.

Collection and preservation of spiders: Periodical surveys were conducted for the collection of spiders from paddy ecosystem. Five fields of paddy were randomly selected from intense paddy growing area. Spiders were collected by general collection, sweeping net and pit fall trap method from 10 quadrates (1 × 1m)

from each field at weekly interval. Five pit fall traps on border (20/field) were installed in each field and collections were made on alternate days. All the collected specimens were preserved in 70% ethanol in specimen tube with proper labelling, indicating locality and date. The collected spiders were identified at ICAR-NBAIR (National Bureau of Agricultural Insect Resources), Bengaluru, India.

Species richness:

Species richness (S) was calculated using the formula

Species richness (S) = number of species collected

Diversity of spiders:

The measurement of diversity of spiders were calculated with computation of Simpsons Diversity Index (SDI)

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

Where, n = number of individuals of each species

N = total number of individuals of all species

Species diversity (H'):

Species diversity (H') was computed based on Shannon-Weiner index of diversity (Shannon,1948)

$$\text{Species diversity (H')} = -\sum_{i=1}^{K} Pi \ln pi$$

where,

pi = Proportion of i^{th} species in sample

pi = fi/n

n = Total number of specimen in sample

fi = Number of specimens of the i^{th} species

k = Total number of species

ln = Natural logarithm (log e)

Species evenness or equitability (E):

Species evenness or equitability (E) was calculated using Kreb's (1975) formula

$$E = \frac{H'}{H'max}$$

where,

H'max = Natural logarithm of the number of species present

0< E < 1, the maximum value being possible in a community in which all species are equally abundant; Any logarithmic base *i.e.*, 10 and 2 may be used to compute H' and E, the evenness value remains the same.

RESULTS AND DISCUSSION

During the year 2017-18, surveys led to collection of total 9 different species of spiders belonging to 7 genera of 4 families (Table 1). The collected total 40 specimens were belonging to four families *i.e.* Araneidae, Oxyopidae, Salticidae and Tetragnathidae. Araneidae was the most dominant family comprising 28 spider specimens belonging o four species (44.44%), while the other family Tetragnathidae revealed three different species (33.33%).The families oxyopidae and salticidae were represented by a single species only.

Table 1: Diversity of spiders collected from paddy fields of Tarapur region of Anand district, Gujarat (2017-18).

Sr. No.	Family	No. of spiders	No. of species	Genus	Species name	Species (%)
1.	Araneidae	28	4	Argiope	*Argiope pulchella* (Thorell)	44.44
				Argiope	*Argiope* sp.	
				Araneus	*Araneus ellipticus* (Tikader & Bal)	
				Neoscona	*Neoscona theisi* (Walckenaer)	
2.	Oxyopidae	4	1	Oxyopes	*Oxyopes javanus* (Thorell)	11.11
3.	Salticidae	1	1	Bianor	*Bianor incitatus* (Thorell)	11.11
4.	Tetragnathidae	7	3	Leucauge	*Leucauge* sp.	33.33
				Tetragnatha	*Tetragnatha* sp. (Okuma)	
				Tetragnatha	*Tetragnatha javana* (Thorell)	

The data pertaining to spider diversity in the year 2018-19 is depicted in the Table 2. Total of 7 different species of spiders belonging to 6 genera of 3 families were collected during the study period. The spider specimens were belonging to three families *i.e.* Araneidae, Tetragnathidae and Thomisidae. Araneidae was the most dominant family with 20 spider specimens belonging to five species (71.43%), while other families Tetragnathidae and Thomisidae reported only one species each (14.29%).

Table 2: Diversity of spiders collected from paddy fields of Tarapur region of Anand district, Gujarat (2018-19).

Sr. No.	Family	No. of spiders	No. of species	Genus	Species name	Species (%)
1.	Araneidae	20	5	Argiope	*Argiope pulchella* (Thorell)	71.43
				Argiope	*Argiope* sp.	
				Araneus	*Araneus ellipticus* (Tikader & Bal)	
				Cyclosa	*Cyclosa* sp. (Thorell)	
				Neoscona	*Neoscona theisi* (Walckenaer)	
2.	Tetragnathidae	1	1	Tetragnatha	*Tetragnatha* sp.	14.29
3.	Thomisidae	1	1	Thomisus	*Thomisus spectabilis* (Doleschall)	14.29

During the year 2019-20, total of 16 species of spiders belonging to 12 genera of 5 families were documented from paddy ecosystem (Table 3). The collected total 86 spider specimens were belonging to five families *i.e.* Araneidae, Oxyopidae, Salticidae, Tetragnathidae and Thomisidae. Araneidae was the most dominant family recorded with 71 spider specimens belonging to seven species (43.75%), while other families Oxyopidae and Salticidae documented three species (18.75%). The families Tetragnathidae and Thomisidae were

represented by one species (6.25%) and two species (12.50%) respectively. Jalajakshi and Usha (2019) Turahalli forest, Karnataka reported Araneidae was the most dominant family with five species (27.7%), while other families Nephilidae, Salticidae, and Oxyopidae revealed only two species each (11.11%).

Similar findings pertaining to spider diversity were reported by various scientists in India. In Gujarat Patel, (2000) and Parasharya and Pathan, (2013) documented Araneidae as the dominant family in paddy and lucerne crop ecosystem, respectively. Further, Prajapati *et al*., (2018) in Navsari, Gujarat reported the dominant family of spider as Araneidae followed by Salticidae and Oxyopidae. Similarly, in other parts of India Araneidae was found to be the dominant family representing the spider diversity. Jose *et al*., (2018) in Kavvayi river basin, Kerala documented the dominant family Araneidae, which constitutes 21.5% of the total spider species collected. The second dominant family was Salticidae, which constitutes 19.5% of total spider population. Al Faruki Ahmed (2018) Goalpara District, Assam found Araneidae was the most abundant family (14 species) with orb weavers being the dominant guild type of spiders.

Table 3: Diversity of spiders collected from paddy fields of Tarapur region of Anand district, Gujarat (2019-20).

Sr. No.	Family	No. of spiders	No. of species	Genus	Species name	Species (%)
1.	Araneidae	71	7	Argiope	*Argiope* sp.	43.75
				Argiope	*Argiope anasuja* (Thorell)	
				Cyrtophora	*Cyrtophora cicatrosa* (Stoliczka)	
				Cyrtophora	*Cyrtophora moluccensis* (Doleschall)	
				Cyclosa	*Cyclosa moonduensis* (Tikader)	
				Neoscona	*Neoscona theisi* (Walckenaer)	
				Neoscona	*Neoscona* sp.	
2.	Oxyopidae	3	3	Oxyopes	*Oxyopes* sp.	18.75
				Oxyopes	*Oxyopes javanus* (Thorell)	
				Peucetia	*Peucetia* sp.	
3.	Salticidae	3	3	Hyllus	*Hyllus* sp.	18.75
				Harmochirus	*Harmochirus* sp.	
				Telamonia	*Telamonia* sp.	
4.	Tetragnathidae	6	1	Tetragnatha	*Tetragnatha* sp.	6.25
5.	Thomisidae	3	2	Runcinia	*Runcinia* sp.	12.50
				Thomisus	*Thomisus* sp.	

Table 4: Catalogue of spider specimens collected from paddy ecosystem, Tarapur region of Anand district, Gujarat during the study period.

Sr. No.	Spider species	No. of spider specimens			Total
		2017-18	2018-19	2019-20	
1.	*Argiope anasuja* (Thorell)	-	-	1	1
2.	*Argiope pulchella* (Thorell)	5	1	-	6
3.	*Argiope* sp.	3	8	28	39
4.	*Araneus ellipticus* (Tikader & Bal)	1	2	-	3
5.	*Bianor incitatus* (Thorell)	1	-	-	1
6.	*Cyclosa moonduensis* (Tikader)	-	-	4	4
7.	*Cyclosa* sp. (Thorell)	-	1	-	1
8.	*Cyrtophora cicatrosa* (Stoliczka)	-	-	5	5
9.	*Cyrtophora moluccensis* (Doleschall)	-	-	1	1
10.	*Harmochirus* sp.	-	-	1	1
11.	*Hyllus* sp.	-	-	1	1
12.	*Leucauge* sp.	2	-	-	2
13.	*Neoscona* sp.	-	-	1	1
14.	*Neoscona theisi* (Walckenaer)	17	8	31	56
15.	*Oxyopes javanus* (Thorell)	4	-	1	5
16.	*Oxyopes* sp.	-	-	1	1
17.	*Peucetia* sp.	-	-	1	1
18.	*Runcinia* sp.	-	-	1	1
19.	*Telamonia* sp.	-	-	1	1
20.	*Tetragnatha javana* (Thorell)	3	-	-	3
21.	*Tetragnatha* sp. (Okuma)	4	1	6	11
22.	*Thomisus spectabilis* (Doleschall)	-	1	-	1
23.	*Thomisus* sp.	-	-	2	2
Total		**40**	**22**	**86**	**148**

Table 5: Simpson's diversity index, Species diversity and species evenness or equitability of spiders collected from paddy ecosystem.

Sr. No.	Diversity indices	2017-18	2018-19	2019-20
1.	Simpson's diversity index (D)	0.75	0.52	0.77
2.	Shannon-Weiner index diversity (H')	1.72	1.52	1.83
3.	Species evenness or equitability (E)	0.7814	0.7789	0.6609

Highest number of spider specimens were recorded in Neoscona genus (57 no.) followed by Argiope (39 no.) and Tetragnatha (11 no.) genus (Table 4). Amongst the three years of study, the highest Simpson's diversity index (D) of 0.77 was recorded in the year 2019-20, which was followed by index 0.75 in the year 2017-18. The similar trend was observed with regard to the index Shannon-Weiner index diversity (H') where highest value was documented in the year 2019-20 (1.83). The data pertaining to species evenness or equitability (E) reveals the low-medium diversity of spider diversity in paddy ecosystem of middle Gujarat region. Study on the diversity of spider from paddy ecosystem also gets support from Prajapati *et al*., (2018), who reported that maximum diversity of spider from paddy fields followed by maize, sugarcane, banana and mango. Jalajakshi and Usha (2019) Turahalli forest, Karnataka reported Simpson's diversity index of 0.151, indicating lesser richness in species diversity. Bhat *et al.*, (2013) documented the diversity, seasonal abundance and status of spiders in cashew agro-ecosystem of Karnataka. They documented Salticidae (30%) and Araneidae (22%) predominant spider families with Shannon index, Simpson index, Evenness index and Margalef Richness index evaluated as 4.20, 0.04, 0.50 and 14.73 respectively.

CONCLUSION

The spiders species *viz*., *Agriope* sp. and *Neoscona theisi* are reported to be the dominant species in rice ecosystem of middle Gujarat. The data pertaining to the species evenness or equitability (E) reveals the mow-medium spider diversity in Tarapur (Lat. 22.4877806 & Long. 72.6582336) area of Anand district of Gujarat. The findings of the present study throws light on the crucial need for conservation of spiders in rice ecosystem and necessitates the rational use of pesticides in rice ecosystem. The future studies are need to be focused on the development of comprehensive strategies for the conservation of spiders to achieve sustenance in insect pest management

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Conflict of Interest. None.

REFERENCES

Al Faruki Ahmed, (2018). A preliminary study on spider diversity and distribution in Goalpara district of Assam, India. *International Journal of Life Sciences*, *6*(4): 937-947.

Bhandarkari, S. V. and Paliwal, G. T. (2019). First distribution record of spider fauna (Aracnida: Araneae) in Navegaon National Park (NNTR) Gondia Maharashtra. *European Journal of Biotechnology and Bioscience*, *7*(1): 01-04.

Bhat, P. S., Srikumar, K. K. and Raviprasad, T. N. (2013). Seasonal diversity and status of spiders (Arachnida: Araneae) in cashew ecosystem. *World Applied Sciences Journal*, *22*(6): 763-770.

Jalajakshi, S. and Usha, R. N. (2019). Spider diversity of suburban South Bangalore, Karnataka. *Indian Journal of Entomology*, *81*(3): 485-487.

Jose, A. C., Sudhin, P. P., Prasad, P. M. and Sreejith, K. A. (2018). Spider Diversity in Kavvayi River Basin, Kerala, Southern India. *Current World Environment*, *13*(1): 100-112.

Keswani, S., Hadole, P. and Rajoria, A. (2012). Check list of Spiders (Arachnida: Araeneae) from India. *Indian Journal of Arachnology*, *1*(1): 1-129.

Krebs, C. J. (1975). *Ecological experimental analysis of distribution and abundance*. Harper & Row, NewYork. p. 694

Parasharya, B. M. and Pathan, V. A. (2013). Diversity of spider fauna in lucerne (*Medicago sativa* L.). *Journal of Biological Control*, *27*(4): 253–259.

Patel, D. T. (2000). Diversity, population dynamics, predatory potential and distribution of spider in rice crop in Anand district, Gujarat. M.Sc. (Agri.) thesis submitted to the Gujarat Agricultural University, Sardar Krushinagar, Gujarat.

Prajapati, J. N., Patel, S. R., Surani, P. M. and Radadia, G. G. (2018). Agrobiont spiders (Araneae) from Five Ecosystems of Navsari Agricultural University, Navsari, Gujarat, India. *International Journal of Chemical Studies*, *6*(3): 2547-2550.

Rajeevan, S., Kunnath, S. M., Varghese, T. and Kandambeth, P. (2019). Spider Diversity (Arachnida: Araneae) in Different Ecosystems of the Western Ghats, Wayanad Region, India. *South Asian Journal of Life Science*, *7*(2): 29-39.

Rani, M. J. and Hima, T. (2018). A preliminary study on the spider diversity of a rice ecosystem in Kumarakom. *Journal of Entomology and Zoology Studies*, *6*(5): 827-829.

Shannon, C. E. (1948). A mathematical theory of communication. *The Bell System Technical Journal*, *27*: 379–423.

Sharma, S., Vyas, A. and Sharma, R. (2010). Diversity and abundance of spider fauna of Narmada River at Rajghat (Barwani) (Madhya Pradesh) India. *Researcher*, *2*(11): 1-5.

World Spider Catalog. World Spider Catalag. Version 19.5. Natural History Museum Bern, 2018. Online at http://wsc.ch, accessed on 15 Oct. 2018.

Yadav, A., Solanki, R., Siliwal, M. and Kumar, D. (2017). Spiders of Gujarat: a preliminary checklist. *Journal of Threatened Taxa*, *9*(9): 10697-10716.

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