

Spider fauna on temperate rice in Kashmir

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ABSTRACT

Extensive surveys for the study on the spiders associated with the temperate rice of Kashmir, India were conducted during 2008 and 2009 in three districts viz., Srinagar, Budgam and Anantnag of Jammu and Kashmir for the study. The temporal distribution of spider fauna was highest in 34th standard meteorological week (SMW) in the locations of district Srinagar and Budgam. In district Anantnag, the peak population of spider was recorded in 33rd SMW. A total 1155 individuals belonging to 40 species, 29 genera under 13 families were recorded. In total, 19 species belonged to web building spiders and coming under four families (Araneidae, Tetragnathidae, Linyphiidae, Theridiidae); 16 species belonged to visual hunting group and coming under 6 families (Lycosidae, Salticidae, Oxyopidae, Gnaphosidae, Pisauridae, Sparassidae) and 5 species belonged to tactile hunter group coming under 3 families (Thomisidae, Clubionidae, Miturgidae). Among web building spiders, *Theridion* sp. and *Neoscona mukerjei* Tikader; among visual hunting group, *Pardosa altitudis* Tikader and Malhotra, *Pisaura* sp¹ and among tactile hunter, *Xusticus* sp. and *Clubiona japonicola* Boesenberg and St. were recorded most abundant species. Among all locations, *P. altitudis* was recorded as most abundant species followed by *Theridion* sp. The relative abundance of visual hunters was higher (48.49 %) than web building (32.38 %) and tactile hunter group of spiders (19.12%). Among all groups of spider, the relative abundance of family Lycosidae (17.41 %) was higher followed by Theridiidae (10.39 %).

Key words: temperate rice, Kashmir, spider, species, biodiversity, abundance, richness

Spiders constitute 80% of the total predatory fauna in rice ecosystem (Wang, 1989). The population densities and species abundance of spider communities can be as high as in natural ecosystems (Khan and Misra, 2004). Spiders mainly prey on insects and they can achieve equilibrium in pest control after which their own numbers are suppressed by their territoriality and intra specific interaction (Khan and Misra, 2003a, b). They are now being incorporated as important biocontrol agent in pest management systems (Khan and Misra, 2009). According to FAO inter country programme for integrated pest control, abundant of wolf spider *Lycosa pseudoannulata* have encouraged the rice farmers of south and south East Asian countries while making pest management decision for hoppers (Stone, 1992). Farmers of these counties through their own experiment are acquainted with the worth of spider in pest management (Ooi, 1996).

In particular, spider communities in areas with a temperate climate achieve equilibrium in the control

of rice pests (Riechert and Lockely, 1984). In spite of this, they have not usually been treated as an important biocontrol agent, because there is so little information on the ecological role of spiders in pest control (Turnbull, 1973, Khan, 2009). In Kashmir, the important and useful spider fauna was explored only in horticultural ecosystem (Khan 2011) and rice ecosystem has not been explored. Hence, an attempt was made to the biodiversity of spider in temperate rice of Kashmir.

MATERIALS AND METHODS

The study was carried out in the temperate rice of Jammu and Kashmir located between 32.17 degree and 36.58-degree north latitude and 37.26 degree and 80.30-degree east longitude with altitude varying from 1500 to 2200 metres above mean sea level. The topography of Kashmir valley is characterized by mountain ranges it encompassed by the mighty Himalayas. For the experiment, three districts viz., Srinagar, Budgam and Anantnag were selected and

from these districts three locations Shalimar, Dara and Syedpora from Srinagar; Khan Sahib, Arath and Rajwan from Budgam and Kokarnag, Khudwani and Khanbal from Anantnag district were selected. Data were collected weekly intervals from 25th standard week to 42nd standard week during 2008 and 2009. To ensure collection of a wide array of spider species from rice ecosystem sampling was conducted by using quadrature method.

Collection of spiders was made from five quadrates (1.0x 1.0 square meters). In each quadrature the spiders were recorded from top to bottom of plants, webs, fold and also soil, while having least disturbance to both the test arthropods. In the quadrature area empty vials measuring 5 cm and 3cm were placed beneath the leaf blades or webs and spiders then tapped loose with the cap. Smaller individuals were picked up with a moisten finger, or by small camel's hair brush. All collected spiders were transported back to the laboratory for sorting, counting and identification. The species were preserved in Oudemans' fluid (85 part – 70 % alcohol, 5 part- glycerine; 5 part- glacial acetic acid) for identification. In the laboratory, specimens were identified on the basis of criteria given by workers (Tikader, 1987; Barrion and Litsinger, 1995; Plantinck, 2010 and Khan and Khan, 2011).

Quantitative estimation of individual species in above mentioned ecosystems were made using the data derived from field survey. Species diversity (H') was based on Shannon-Wiener function as detailed by Margalef (1957). Evenness (J') was also calculated to estimate the equitability component of diversity using the formula (Pielou, 1975). Richness (ma) was computed by using formula (Pielou, 1966). All statistical analysis was performed using R software programme (R Development Core Team, 2008).

RESULTS AND DISCUSSION

The temporal distribution of spider fauna was recorded from 25th standard week to 42nd standard week in temperate rice ecosystem of Kashmir during 2008-2009. The peak population of spider fauna was recorded in 34th standard week in Srinagar and Budgam district which ranged from 13-16 spider quadrature⁻¹. In district Anantnag, the peak population of spider was recorded in 33rd standard week. Among all locations, the highest population of spider was recorded in Shalimar (16/

quadrature) followed by Rajwan and Khudwani (15/ quadrature).

A total of 1155 individuals of spider fauna were collected from temperate rice ecosystem of Kashmir during 2008-2009 were grouped on the basis of preying nature, family, genus and species (Table 1). In general, spiders find shelter or hide either in soil or in between plant/crop canopy. The ground dwelling spiders live on plant as well for searching the preys. On the basis of behaviour and preying nature, they may be either web-building or non-web building (hunting). The hunting spiders were either visual hunters or tactile hunters. The total collected web-spinning spiders are again categorized into four group i.e., orb-spinning spider (family-Araneidae), four jawed spider (family-Tetragnathidae), dwarf spider (family-Linyphiidae), and comb foot spider (family-Theridiidae). The visual hunting spiders are divided into 6 groups i.e., wolf spider (family-Lycosidae), Jumping spider (family-Salticidae), lynx spider (family-Oxyopidae) and ground spider (family-Gnaphosidae), nursery web spiders (family-Pisauridae) and giant crab spiders or huntsman spiders (family-Sparassidae) and tactile hunting spiders are categorized as crab spider (family-Thomisidae), sac spider or 2-clawed spider (family-Clubionidae) and prowling spiders or yellow sac spiders (family-Miturgidae). The collected spider species were grouped on the basis of their preying nature was done by workers (Sebastian *et al.*, 2005; Khan, 2006, 2009)

Thirteen families, 29 genera and 40 species were observed in the survey conducted in temperate rice of Kashmir. Among all species, 19 species were web-spinning, 18 species were visual hunter and 5 species were tactile hunters. Out of 19 species of web-spinning spiders, 9 species were belong to family-Araneidae; 5 species to family-Tetragnathidae; 2 species to family-Theridiidae; 3 species to family-Linyphiidae. Among 16 species of visual hunter, 3 species belonged to family-Lycosidae; 5 species to family-Salticidae and 2 species to each family-Oxyopidae, Gnaphosidae, Pisauridae and Sparassidae. Out of 5 species of tactile hunter, 2 species were belong to each family-Thomisidae and Clubionidae; one species to family-Miturgidae (Table 1 and 3). In Asian countries, the studies were taken in rice ecosystem and reported 342 species from Philippines and South East Asia (Barrion and Litsinger, 1995), 60 species from Sri

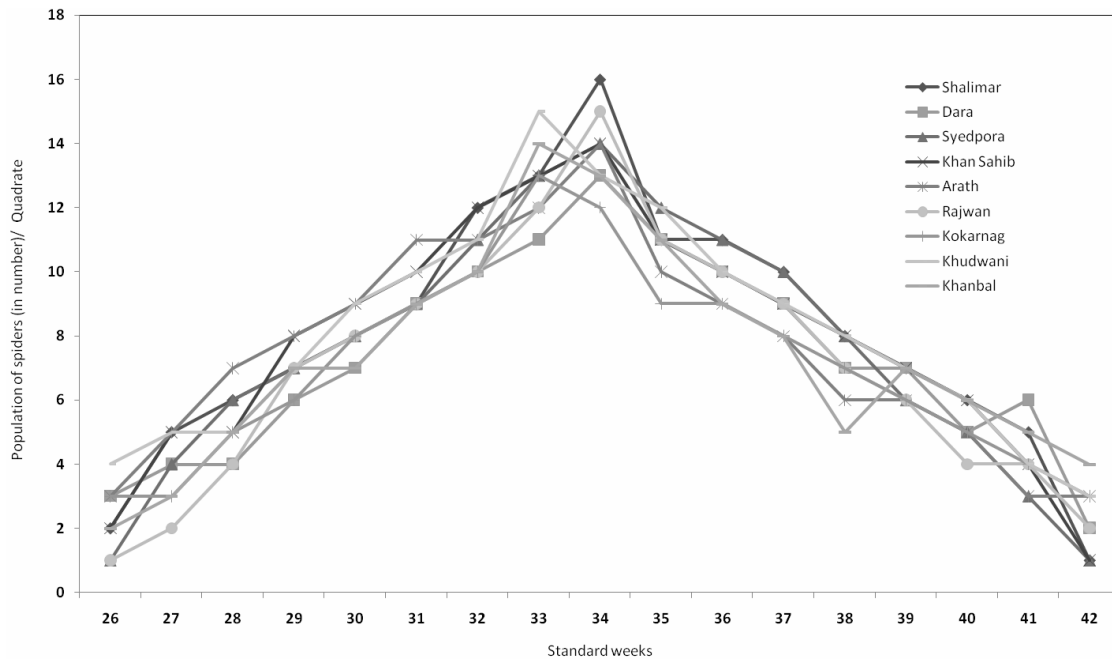


Fig. 1. Temporal distribution of spider fauna of temperate rice ecosystem in different locations of Kashmir during 2008-2009

Lanka (Bambaradeniya and Edirisinghe, 2001) and from India, 92 species from Central Kerala (Sebastian *et al.*, 2005), 21 species from Tamil Nadu (Kumar and Velusamy, 1996) and 39 species from Uttar Pradesh (Khan, 2006).

Among 40 species of spiders observed from Kashmir rice ecosystem, 27 species were recorded from Shalimar, 25 species from Dara and 29 species from Syedpora sites of district Srinagar. From district Budgam, 28 species were recorded from Khan Sahib, 28 species from Arath and 29 Species from Rajwan location. In District Anantnag, 27 species were observed from Kokarnag, 28 species from Khudwani and 27 species from Khanbal location. Out of 19 species of web-spinning spiders, *Neoscona mukerjei* Tikader of family Araneidae; *Tetragnatha* sp. of family Tetragnathidae and *Theridion* sp. of family Theridiidae was found abundant in rice ecosystem of Kashmir. Among 16 species of visual hunters, *Lycosa altitudus* Tikader and Malhotra of family Lycosidae; *Marpissa* sp. of family Salticidae; *Oxyopes javanus* (Thorell) of family Oxyopidae; *Setaphis* sp. of family Gnaphosidae and *Pisaura*¹ of family Pisauridae were found abundant in Kashmir. In 5 species of tactile hunter, *Xysticus* sp. of family Thomisidae; *Clubiona japonicola* (Boesenberg and Strand) of family Clubionidae and in

family Miturgidae only a species *Cheiracanthium* sp. was recorded and found abundant in rice ecosystem of Kashmir (Table 1). Among all locations, *P. altitudus* was recorded as most abundant species followed by *Theridion* sp. *Tetragnatha javana* Thorell, *N. mukerjei* and *Latrodectus* sp. was found dominant in all locations of Srinagar, Budgam and Anantnag district, respectively. *Araneus anantnagensis* Tikader and Bal was recorded in only Anantnag district of Kashmir. Almost similar finding was reported by Sebastian *et al.* (2005) that 92 species, 47 genera and 16 families were recorded during the study period. Araneidae and Tetragnathidae were the dominant families and *Tetragnatha mandibulata* Walckenaer the most abundant species.

The maximum populations of spider were coming under the group of visual hunter (48.49 %) followed by web-building spiders (32.38 %). The highest population of visual hunters were recorded in district Budgam at Khan Sahib Location (51.49 %) followed by Anantnag district at Kokarnag location (51.29 %) (Table 2). Among visual hunting families, the population of Lycosidae (17.41 %) was higher than other families in all locations. Out of web-spinning families, the relative abundance of family Theridiidae (10.39 %) was observed greater followed by Tetragnathidae (9.61 %).

Table 1. Biodiversity of spider fauna in temperate rice ecosystem of Kashmir during 2008- 2009

Group, Family, Genus, species	Biodiversity of spider fauna of temperate rice ecosystem of Kashmir								
	Srinagar			Budgam			Anantnag		
	Shalimar	Dara	Syedpora	Khan Sahib	Arath	Rajwan	Kokarnag	Khudwani	Khanbal
<u>Web builders</u>									
Family-Araneidae									
<i>Araneus anantnagensis</i> Tikader & Bal	-	-	-	-	-	-	+	+	+
<i>Araneus trifolium</i> (Hentz)	+	-	+	-	-	-	-	-	-
<i>Araneus</i> sp.	+	-	+	-	+	+	-	+	-
<i>Argiope</i> sp.	-	-	-	-	-	-	+	+	-
<i>Cyclosa elongata</i> (Biswas & Raychaudhuri)	-	+	-	+	-	+	+	-	-
<i>Neoscona</i> sp.	+	-	+	+	+	-	-	-	-
<i>Neoscona theisi</i> (Walckenaer)	-	-	-	+	+	-	+	+	-
<i>Neoscona mukerjei</i> Tikader	+	+	+	+	+	+	-	-	+
<i>Nephila</i> sp.	-	+	+	+	+	+	-	+	+
Family-Tetragnathidae									
<i>Leucauge celebesiana</i> (Walckenaer)	-	-	-	-	+	+	+	+	+
<i>Leucauge</i> sp.	+	+	+	+	+	+	-	-	+
<i>Tetragnatha</i> sp.	+	+	+	+	+	+	+	+	+
<i>Tetraganagha javana</i> Thorell	+	+	-	-	-	+	-	-	-
<i>Tetraganagha maxillosa</i> Thorell	+	-	-	-	+	-	+	+	-
Family- Theridiidae									
<i>Latrodectus</i> sp.	-	-	-	-	-	-	+	-	+
<i>Theridion</i> sp.	+	+	+	+	+	+	+	+	+
Family- Linyphiidae									
<i>Eriogona rohtagensis</i> Tikader.	-	+	-	+	-	-	+	-	+
<i>Lepthyphantes</i> sp.	+	-	-	-	+	+	-	+	+
<i>Linyphia</i> sp.	+	-	+	-	-	-	-	+	-
<u>Visual Hunters</u>									
Family-Lycosidae									
<i>Arctosa</i> sp.	-	+	+	+	-	+	-	-	+
<i>Lycosa</i> sp.	+	+	+	+	+	+	+	+	+
<i>Pardosa altitudis</i> Tikader and Malhotra	+	+	+	+	+	+	+	+	+
Family- Salticidae									
<i>Marpissa</i> sp.	-	+	+	+	-	+	+	+	-
<i>Myrmarachne</i> sp.	+	-	-	+	+	+	+	+	+
<i>Myrmarachne himalayensis</i> Narayan	-	+	+	+	-	-	-	+	-
<i>Phidippus</i> sp.	+	-	+	-	+	+	-	-	+
<i>Zygoballus</i> sp.	+	+	+	-	+	+	+	-	+
Family- Oxyopidae									
<i>Oxyopes javanus</i> (Thorell)	+	+	+	+	+	+	+	+	+
<i>Oxyopes ratane</i> Tikader	+	+	+	+	+	+	+	+	+
Family-Ganphosidae									
<i>Setaphis</i> sp.	+	+	+	+	+	+	+	+	+
<i>Zelotes</i> sp.	-	+	+	+	+	+	-	+	-
Family- Pisauridae									
<i>Pisaura</i> sp. ¹	+	+	+	+	+	+	+	+	+
<i>Pisaura</i> sp. ²	+	-	+	+	+	+	+	-	-
Family-Sparassidae									
<i>Olios</i> sp.	-	+	+	+	+	-	+	+	+
<i>Sparassus</i> sp.	+	-	+	+	-	+	+	+	+
<u>Tactile hunters</u>									
Family-Thomisidae									
<i>Thomisus</i> sp.	+	+	+	+	+	+	+	+	+
<i>Xysticus</i> sp.	+	+	+	+	+	+	+	+	+
Family-Clubionidae									
<i>Clubiona</i> sp.	+	+	+	+	+	+	+	+	+
<i>Clubiona japonicola</i> (Boesen berg and St.)	+	+	+	+	+	+	+	+	+
Family-Miturgidae									
<i>Cheiracanthium</i> sp.	+	+	+	+	+	+	+	+	+
Total species Collected in each location	27	25	29	28	28	29	27	28	27
Total species Collected in all location	40								

+ = Species present, - = Species absent

Table 2. Relative abundance of spider fauna of different families in temperate rice ecosystem in different districts of Kashmir during 2008-2009

Family	Srinagar				Badgam				Anantnag				Total							
	Shalimar		Dara		Syedpora		Khan sahib		Arath		Rajwan		Kokarnag		Khanbal		n	%		
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%				
Web builders																				
Araneidae	11	8.03	9	7.26	10	7.75	9	6.72	10	7.69	8	6.61	10	8.55	13	9.42	9	7.20	89	7.71
Tetragnathidae	10	7.30	11	8.88	12	9.30	11	8.21	12	9.23	13	10.75	14	11.97	18	13.04	10	8.00	111	9.61
Theridiidae	15	10.95	12	9.67	13	10.08	14	10.45	15	11.54	17	14.05	11	9.40	10	7.25	13	10.40	120	10.39
Linyphiidae	6	4.38	7	5.65	9	6.98	5	3.73	8	6.16	4	3.30	2	1.70	5	3.62	8	6.40	54	4.67
Sub total	42	30.66	39	31.45	44	34.11	39	29.11	45	34.62	42	34.71	37	31.62	46	33.33	40	32.00	374	32.38
Visual Hunters																				
Lycosidae	27	19.71	22	17.74	20	15.50	25	18.66	23	17.69	19	15.70	24	20.51	22	15.95	19	15.20	201	17.41
Salticidae	7	5.11	8	6.45	8	6.20	10	7.46	9	6.92	10	8.26	8	6.84	9	6.52	9	7.20	78	6.75
Oxyopidae	7	5.11	9	7.25	6	4.65	10	7.46	9	6.92	8	6.61	10	8.55	9	6.52	10	8.00	78	6.75
Gnaphosidae	14	10.22	11	8.87	12	9.30	12	8.96	6	4.62	8	6.61	9	7.69	12	8.69	13	10.40	97	8.40
Pisauridae	8	5.84	8	6.46	8	6.21	7	5.22	9	6.93	8	6.61	5	4.28	8	5.80	6	4.80	67	5.80
Sparassidae	5	3.65	4	3.23	4	3.10	5	3.73	4	3.07	5	4.14	4	3.42	4	2.90	4	3.20	39	3.38
Sub total	68	49.64	62	50.0	58	44.96	69	51.49	60	46.15	58	47.93	60	51.29	64	46.38	61	48.80	560	48.49
Tactile hunters																				
Thomisidae	10	7.30	9	7.26	12	9.30	10	7.46	12	9.23	8	6.61	10	8.55	12	8.70	9	7.20	92	7.96
Clubionidae	8	5.84	7	5.64	7	5.43	9	6.72	7	5.38	5	4.14	6	5.12	7	5.07	9	7.20	65	5.63
Miturgidae	9	6.56	7	5.65	8	6.20	7	5.22	6	4.62	8	6.61	4	3.42	9	6.52	6	4.80	64	5.54
Sub total	27	19.70	23	18.55	27	20.93	26	19.40	25	19.23	21	17.36	20	17.09	28	20.29	24	19.20	221	19.13
Total	137	100.0	124	100.0	129	100.0	134	100.0	130	100.0	121	100.0	117	100.0	138	100.0	125	100.0	1155	100.0

n= number of spider collected, %= cumulative per cent of collected spiders

The maximum population of web-spinning spiders were recorded at Rajwan location of district Budgam followed by Arath location of same district. Among tactile hunting spiders, most of the spiders were coming under family Thomisidae (7.96%) followed by family Clubionidae (5.63 %). The maximum population of tactile hunting spiders were recorded at Syedpora (20.93 %) location of Srinagar district followed by Khudwani location (20.29 %) of Anantnag district (Table 2). According to Sebastian *et al.* (2005) the widely distributed families were Araneidae, Lycosidae, Tetragnathidae and Salticidae in Kerala and these groups comprised 60-70 % of total collected spider species.

Species diversity and evenness of indices of visual hunting spiders were observed greater as compared to web-building spiders and tactile hunting spiders. Species richness of web-building spiders was higher than other group of spiders. Among web-building spiders, species diversity was higher in Theridiidae followed by Tetragnathidae but evenness of indices were higher in Araneidae followed by Tetragnathidae. Species richness of web-building spiders of family Theridiidae was observed higher followed by Linyphiidae. Out of all the visual hunting spiders, species diversity and evenness of indices of was higher for the family Lycosidae (Table 3). Among all locations, species diversity and species richness among tactile hunter richness was observed to be the highest in Syedpora and Khudwani, respectively. Similarly, Kumar and Velusamy (1996) reported that the species richness was greater in cultivated rice fields of Coimbatore than in Aliyanagar and Karaikal of Tamil Nadu.

As species are added, and become evenly distributed, diversity increases. In a diverse situation, species cannot be very dominant and in a low diversity community one or two species will be much more abundant than others (Pielou, 1969, 1975). Margalef's richness index, Shannon-Weiner diversity index and Pielou's evenness index of visual hunters was greater followed by web-builders in temperate rice ecosystem. Among the all locations, spider diversity was observed greater in Syedpora, species richness and variation in communities between species was recorded highest in Khudwai. However, the present finding is in accordance with that of Kamal *et al.* (1992) from Bangladesh; Ansari and Pawar (1992) from Karnataka and from

Table 3. Parameter of abundance of spider fauna in temperate rice of Kashmir, 2008 -2009

Spider group/family	Parameter of abundance of spider fauna in rice ecosystem of Kashmir				
	N	S	J'	H'	ma
Web-building					
Araneidae	89	9	1.167	1.114	4.115
Tetragnathidae	111	5	1.458	1.018	1.955
Theridiidae	120	2	3.265	0.983	0.962
Linyphiidae	54	3	2.789	1.331	1.154
Sub-total	374	19	0.383	0.490	6.998
Visual Hunter					
Lycosidae	201	3	1.590	0.759	0.868
Salticidae	78	5	1.681	1.174	2.114
Oxyopidae	78	2	3.897	1.173	0.528
Gnaphosidae	97	2	3.574	1.076	0.503
Pisauridae	67	2	4.106	1.236	0.547
Sparassidae	39	2	4.890	1.472	0.628
Sub-total	560	16	0.250	0.314	6.186
Tactile hunter					
Thomisidae	92	2	3.651	1.099	0.509
Clubionidae	65	2	4.149	1.249	0.551
Miturgidae	64	1	0.000	1.256	0.000
Sub-total	221	5	1.028	0.718	1.706
Total	1155	40			

N = Total number of individual in all species, S = number of species, J' = indices of evenness, H' = species diversity, ma = species richness

Kerala, Sebastian *et al.* (2005) in that various diversity indices across different elevations yielded only minimal differences in most of the indices used. This suggests that the effect of elevation on the diversity of spiders is not very drastic in the rice ecosystems.

A reasonable variation exists in the altitude of some of the selected locations above mean sea level; Srinagar (1730 metres), Anantnag (1990 metres), Budgam (1581 metres). It may be concluded that vegetation complexity is an important determinant of species richness for spiders. Besides, some of the local factors may also modify the microclimate of the selected locations like the presence of a huge water body (Dak Lake) near Syedpora and Shalimar, mountainous ranges on the North and North East of Kokarnag and Khudwai, although the average climatic condition of the selected locations is the same.

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