



Research Note

Diversity and foraging behaviour of spider (Arachnida: Araneae) in the temperate maize ecosystem of Kashmir

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ABSTRACT: The species composition, habitat associations, web construction and foraging behaviour of spiders were studied in temperate maize ecosystem of Kashmir. Thirty seven species under 13 families and 28 genera were recorded from all study sites. Most spiders belonged to the Lycosidae, Theridiidae, Tetragnathidae, Salticidae, Pisauridae and Gnaphosidae. These families comprised 62.84% of total spiders collected in maize ecosystem. The maximum number of species was recorded in the family Araneidae but their numbers were quit low. The maximum proportion of spiders were in the group of visual hunter (53.93%) followed by web-building spiders (28.55%) which includes orb-web builders (15.94%) and space-web builders (12.61%) and the lowest was 17.52% of tactile hunters. The several species of spiders encountered in each location exhibited specific habitat preferences and segregated the microhabitat in to numerous niches. Since several maize insect pests regularly dwell frequently of these niches, diverse spider species might act in a complementary mode to suppress insect pest populations.

KEY WORDS: Biodiversity, foraging behaviour, habitat associations, maize ecosystem, species composition, spider, relative abundance.

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Over 42,400 spider species belonging to 110 families and 3849 genera are known currently (Platnick, 2011), although assessment of their total number occur worldwide vary from 60,000 to 1,70,000 (Coddington and Levi, 1991) and more than 1,000 species are so far identified from India (Siliwal *et al.*, 2005). Spiders are generalist predators colonizing almost all habitats and are relatively abundant and diverse in natural systems (Nyffeler, 1999). Such a widespread and diverse group of animals obviously includes a wide range of life styles, behaviours and morphological and physiological adaptations (Turnbull, 1973). Due to their diversity and abundance they significantly reduce plant damage caused by insects and they can achieve equilibrium in pest control (Khan and Misra, 2004), often their own numbers are suppressed by their territoriality and cannibalism (Khan and Misra, 2003a, b). For some time, spiders have been considered important predators which help regulate the population densities of insect pests (Khan and Misra, 2009). In particular, spider communities in area with a temperate climate achieve equilibrium in the control of agricultural pests (Sackett *et al.*, 2008; Khan, 2011). In spite of this, they have not

usually been treated as an important bio-control agent, because there is so little information on the ecological role of spiders in pest control (Riechert, 1999; Khan and Misra, 2006).

In consequence, recent studies on biodiversity have dealt with functional aspects, taking into account the role of a given species in the biocoenosis, its trophic relations with other species and how these relations depend on habitat and landscape structure (Oberg *et al.* 2007; Richardson and Hanks, 2009). In spite of this, they have been neglected as potential biological control agents and attributed this in part to their generalist predatory habits (Khan, 2006). Reichert and Lockley (1984) and Khan (2009), however, emphasized the contribution of the spider community as a whole to insect control in agro ecosystems. They recognized that the diverse prey capture strategies and microhabitat exploitation of different species would exert predation pressure on a variety of pests and different life stages of the same pest (Miliczky *et al.*, 2000). Both argued for preservation of spider diversity in agro-ecosystems.

Hence, they play a vital role in agro ecosystem as predators and so are of economic values due to their pest control function in various crops including maize (Lang *et al.*, 1999). In Kashmir, no work has been conducted earlier on spider diversity in maize field crops. This is the first attempt to study the biodiversity, habitat association, web construction and foraging behaviour of spider fauna (Arachnida: Araneae) of temperate maize ecosystem of Kashmir.

For the experiment, three districts *viz.*, Srinagar, Budgam and Anantnag of Kashmir, India 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. The samples were taken at fortnightly interval from May to October (growing season) during 2008 and 2009 for two consecutive years. All the samples were collected during the day time.

Sampling was conducted using three different techniques namely; sweep net, quadrat method and pitfall trap for plant canopy, understory vegetation and ground surface, respectively. In sweep net method, spiders were collected by making double stroke sweeps by insect collection hand sweeping net (diameter 32 cm and handle 92 cm). Each stroke of sweep-net was complete oscillation and was repeated five times randomly from five different places. The spider and associated pests collected per sweep was counted as average per sweep. In quadrat method (which is made of wooden frame (1.0 x 1.0 square meters), collection of spiders were made from five quadrat, four from the four corners of the orchard, leaving sufficient core area of about 10 meters from the borders and one from the middle of the field randomly. In each quadrat (1.0 x 1.0 square meters area), the spiders were collected from the understory vegetation under plant canopy carefully with least disturbance of arthropod fauna. For the study of the ground dwelling spider, pitfall trap was used at the experimental sites. The traps were of plastic cups (diameter 9 centimetres and height 12 centimetre) buried in the soil at the surface level, containing ethylene glycol as preservative filling the bottom up to 2 centimetre height. Five traps were placed in a row, 10 meter apart in the orchard leaving 5 meter from the edges to avoid the core effect. All the traps were emptied and samples were collected at fortnightly interval and again filled with preservative. The types of web constructions and foraging behaviour activities of different group of spider fauna were recorded visually in the maize ecosystem at the time of investigation.

Identification of spiders

All collected spiders were transported to the laboratory for sorting, counting and identification. Labels containing all pertinent information *viz.*, date of collection, location, crops etc. were placed inside the vials with the specimens. The collected samples were preserved in Oudemans' fluid (85 part – 70% alcohol, 5 part-glycerine; 5 part-glacial acetic acid) (Barrion and Litsinger, 1995) for identification. In the laboratory, specimens were identified on the basis of criteria given by workers (Tikader and Bal, 1980; Tikader, 1987; Barrion and Litsinger, 1995; Plantinck, 2011; Khan and Khan, 2011). Species were classified according to Plantinck (2011). Additionally the recorded spiders were divided into four main guilds (Nyffler, 1982; Khan, 2009); orb-web builder (Aranidae, Tetragnathidae), space web builder (Linyphiidae and Theridiidae), visual hunter (Lycosidae, Salticidae, Oxyopidae, Gnaphosidae, Pisauridae and Sparassidae) and tactile hunter (Thomisidae, Clubionidae and Miturgidae).

All spiders collected are listed in Table 1. There were 13 families, 28 genera and 37 species represented. Among the 37 species of spiders were observed from temperate maize ecosystem of Kashmir, 25 species were recorded from Shalimar, 20 species from Dara and 25 species from Syedpora location of district Srinagar. From district Budgam, 27 species were recorded from Khan Sahib, 24 species from Arath and 26 Species from Rajwan location. In District Anantnag, 25 species were observed from Kokarnag, 26 species from Khudwani and 25 species from Khanbal location. Most of the spiders belonged to the family Lycosidae, Theridiidae, Tetragnathidae, Salticidae, Pisauridae and Gnaphosidae. These families comprised 62.84% of total spiders collected in maize ecosystem (Table 2). The maximum population of spiders belonged to group of visual hunter (53.93%) followed by web-building spiders (28.55%) which includes orb-web builders (15.94%) and space-web builders (12.61%) and the lowest was 17.52 % of tactile hunters (Table 3). Literature on spider fauna of maize ecosystem is lacking compared to other ecosystem. Similar reports have been documented based on numerous studies conducted elsewhere (Bogya *et al.*, 1997; Sackett *et al.*, 2008; Khan, 2011). There was a total 37 species reported in this study, while Bogya *et al.* (1997); Khan (2011) reported 66 and 51 species and respectively from their study regions. In Asian countries, the studies were taken mostly in rice ecosystem and about 342 species from Philippines and South East Asia (Barrion and Litsinger, 1995), 60 species from Sri Lanka (Bambaradeniya and Edirisinghe, 2001) were reported.

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

Spider group, Family, Genus, species	Srinagar			Budgam				Anantnag			Total	Spider captured in sampling method
	Shalimar	Dara	Syedpora	Khan sahib	Arath	Rajwan	Kokarnag	Khudwani	Khanbal			
ORB-WEB BUILDERS												
Family-Araneidae Dahl												
<i>Neoscona theisi</i> (Walckenaer)	1	2	3	-	2	2	-	-	-	-	10	S, Q
<i>Neoscona mukerjei</i> Tikader	2	-	2	3	-	4	3	2	-	-	16	S, Q
<i>Neoscona</i> sp.	1	2	2	1	1	1	1	1	2	2	12	S, Q
<i>Araeus trifolium</i> Hentz	1	-	-	-	-	-	-	-	-	-	1	S, Q
<i>Araeus phalgaenensis</i> Tikader & Bal	-	1	1	1	2	-	-	1	1	1	7	S, Q
<i>Nephila</i> sp.	3	-	2	1	-	1	1	1	2	2	11	S, Q
<i>Cyclosa elongata</i> Biswas & Raychaudhari	-	-	-	2	3	-	-	1	-	-	6	S, Q
<i>Argiope</i> sp.	-	-	-	-	-	-	1	2	2	2	5	S, Q
Sub total	8	5	10	8	8	8	6	8	7	7	68	
Family-Tetragnathidae Menge												
<i>Tetragnatha</i> sp.	8	14	9	4	5	5	4	6	3	3	58	S, Q
<i>Tetragnagha maxillosa</i> Thorell	3	-	-	2	-	-	7	-	2	2	14	S, Q
<i>Tetragnagha javana</i> Thorell	-	-	-	2	-	-	-	-	-	-	2	S, Q
<i>Leucauge celebesiana</i> (Walckenaer)	3	-	2	-	4	3	-	4	4	4	20	S, Q
Sub total	14	14	11	8	9	8	11	10	9	9	94	
SPACE-WEB BUILDERS												
Family - Theridiidae Sundevall												
<i>Theridion</i> sp.	12	12	13	13	10	11	6	6	9	9	92	S, Q
<i>Latrodectus</i> sp.	-	-	-	-	-	3	1	-	2	2	6	S, Q
Sub total	12	12	13	13	10	14	7	6	11	11	98	
Family - Linyphiidae Blackwall												
<i>Leptyphantes</i> sp.	3	-	1	4	-	4	5	-	3	3	20	S, Q
<i>Eriogona rohtagensis</i> Tikader.	1	6	-	-	-	2	-	1	-	-	10	S, Q
Sub total	4	6	1	4	0	6	5	1	3	3	30	

Spider group, Family, Genus, species	Srinagar			Budgam				Anantnag			Total	Spider captured in sampling method
	Dara		Syedpora	Khan sahib	Arath	Rajwan	Kokarnag	Khudwani	Khanbal			
	Shalimar											
VISUAL HUNTERS												
Family - Lycosidae Sundevall												
<i>Lycosa altitudis</i> Tikader and Malhotra.	18	20	18	29	20	15	14	19	15	168	Q, P	
<i>Pardosa ladakhensis</i> Tikader	2	4	2	-	2	3	1	3	2	19	Q, P	
<i>Arctosa</i> sp.	-	-	3	-	-	1	1	-	-	5	Q, P	
Sub total	20	24	23	29	22	19	16	22	17	192		
Family - Salticidae Blackwall												
<i>Phidippus</i> sp.	-	7	-	4	6	-	2	1	-	20	S, Q, P	
<i>Marpissa</i> sp.	3	-	-	-	2	4	-	2	-	11	S, Q, P	
<i>Myrmarachne</i> sp.	6	-	10	8	1	5	3	4	4	41	S, Q, P	
<i>Myrmarachne himalayensis</i> Narayan	-	-	5	-	-	-	-	2	-	7	S, Q, P	
<i>Zygoballus</i> sp.	-	2	-	2	2	-	4	-	1	11	S, Q, P	
Sub total	9	9	15	14	11	9	9	9	5	90		
Family - Oxyopidae Thorell												
<i>Oxyopes ratane</i> Tikader	6	v	4	8	5	6	-	14	-	43	S, Q, P	
<i>Oxyopes javanus</i> (Thorell)	-	7	1	4	3	2	6	-	13	36	S, Q, P	
Sub total	6	7	5	12	8	8	6	14	13	79		
Family - Gamphosidae Pocock												
<i>Setaphis</i> sp.	4	7	5	5	6	5	6	14	5	57	Q, P	
<i>Zelotes</i> sp.	2	6	2	2	4	3	4	-	1	24	Q, P	
Sub total	6	13	7	7	10	8	10	14	6	81		
Family - Pisauridae												
<i>Pisaura</i> sp. 1	7	5	9	5	9	8	8	6	7	64	Q, P	
<i>Pisaura</i> sp. 2	-	2	3	2	3	4	-	2	5	21	Q, P	
Sub total	7	7	12	7	12	12	8	8	12	85		
Family-Sparassidae Simon												
<i>Sparassus</i> sp.	3	-	1	3	-	1	1	1	2	12	S, Q, P	
<i>Olios</i> sp.	1	2	-	1	3	-	1	-	1	9	S, Q, P	
Sub total	4	2	1	4	3	1	2	1	3	21		

Spider group, Family, Genus, species	Srinagar			Budgam			Anantnag			Total	Spider captured in sampling method	
	Dara		Syedpora	Khan sahib		Rajwan	Kokarnag		Khudwani			Khanbal
	Shalimar				Arath							
TACTILE HUNTERS												
Family – Thomisidae Sundevell												
<i>Thomisus</i> sp.	3	2	2	4	3	8	4	3	3	3	32	Q, P
<i>Xysticus</i> sp.	5	9	5	7	5	-	7	3	3	4	43	S, Q, P
Sub total	8	11	7	11	8	8	11	6	6	7	75	
Family – Clubionidae Wagner												
<i>Clubiona</i> sp.	5	3	4	3	6	11	3	4	4	2	49	Q, P
<i>Clubiona japonicola</i> Boesenberg et	-	2	-	4	-	3	4	-	1	-	10	Q, P
Sub total	5	5	4	7	6	14	7	5	5	2	59	
Family – Miturgidae Simon												
<i>Cheiracanthium</i> sp.	5	-	3	2	5	-	2	9	9	11	44	S, Q, P
Sub total	5	0	3	2	5	0	2	9	9	11	44	
Total	108	115	112	126	112	115	126	109	113	106	1016	
Species Collected in each locations (No.)	25	20	25	27	24	26	27	25	26	25	37	

S = Sweep net, Q = Quadrate, P = Pitfall trap

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) were reported. Duffey (1966) recognized habitat as a major factor in determining the general composition of spider community. Some spiders, particularly hunting spiders are capable of moving from one habitat stratum to another in search of food. Therefore, factors which influence spider numbers and proportions in any ecosystem, irrespective of the effects of insecticides, plant size, vigour, age and variety, ground cover and prey density.

Observations on occurrence, habitats of individual species/groups, web construction and foraging behaviours are presented by family below. There is very little information available to discuss with habitats of individual species, groups, web construction and foraging behaviours in case of spider of maize ecosystem.

Orb-Web building spiders

Orb-web building spiders were representing 15.94 % of total spiders collected during study (Table 2). Two families were recorded under orb-web building spiders are Araneidae and Tetragnathidae.

Family-Araneidae Dahl (Orb-weaving spider)

The Araneids were represented by a large species complex, but made up only 6.69% of the total collected spider. The highest population (8.93%) was recorded at Syedpora and the lowest at Dara (4.35%) (Table 2). Presence of longitudinal thoracic groove in female separates *Neoscona* from all members of the genus *Araneus* and carapace with 'U' shaped junction between cephalic and thoracic region distinguish *Cyclosa* from *Neoscona* and *Araneus*. To capture the prey, *Neoscona* and *Araneus* construct highly specialized vertical orb webs consisting of many concentric rings and series of radii which characteristically hang down from the center of the web. They constructed closed centred web on upper surface of maize plants. *Nephila* constructed golden orb-web and *Cyclosa* were nocturnal in habit but found in web during day, old web torn after few days and is replaced or repaired in the evening. Tikader (1982) reported that the spiders hang in the web in a small gap at the centre between the upper half and lower half of the structure. *Argiope* make circular web in the field provided with 'X' marked stabulimentum (zigzag ribbon like structure across the hub). *Neoscona* spp., *Neoscona theisi* (Walckenaer), *Neoscona mokerjei* Tikader, *Neoscona trifolium* Hentz, *Araneus phalgaenensis* Tikader and Bal, *Nephila* spp., *Cyclosa elongata* Biswas

& Raychaudhari, *Argiope* spp. were recorded under family Araneidae. Alate aphid, whiteflies, leafhoppers and other soft body insect, sometime butterflies, moths, lepidopterous larvae, beetles and wasps were found in their web.

Family-Tetragnathidae Menge (Long jawed spider)

Most of the *Tetragnathids* are long bodied spiders build webs in between leaves of maize plants. They represented 9.25% of total spiders collected during study and second position in abundance among all web building spiders. The highest population (12.96%) was recorded at Shalimar and the lowest at Khan Sahib (6.35%). The snare has few radii and an open hub on which the spider sit preferred wet area. Build open centred weak web and to feed upon trapped insects. *Leucauge* construct horizontal plane web in low bushes during the day. They are very quick to construct their web and hang at the centre in the upside down posture almost every day they build their nest often removing their old one. Under the family Tetragnathidae, the species were recorded are *Tetragnatha* sp., *Tetra-ganagha maxillosa* Thorell, *Tetraganagha javana* Thorell and *Leucauge celebesiana* (Walckenaer). Moths, beetles, hoppers, grass hopper nymph and adults, alate aphids, white flies, lepidopterous larvae, flying insects and other small insect were found in their web.

Space-web building spiders

Space-web building spiders constituted 12.61% of the total spiders collected during study (Table 2). Two families were recorded under space-web building spiders are Theridiidae and Linyphiidae.

Family-Theridiidae Sundevall (Comb-foot or Cob-web weaver spider)

Among all web building spider it was most abundant spider family and represented 9.66% population of spiders and the highest population (12.16%) was recorded at Rajwan in district Budgam and lowest at Khudwani (5.31%) in district Anantnag. The main character of this family is tarsus of fourth leg with a comb like series of serrated bristles. Most of the comb footed spiders catch their prey in webs made of dense sheets and viscid strands. Spiders build crisscross threads, tangled or irregular snares with threads from which they suspend themselves in an inverted position while waiting for the prey. They prey principally on small weak flying insects such as aphids, leafhoppers, and small flies and wasps. *Theridion* sp. and *Latrodectus* sp. were recorded from maize ecosystem and *Theridion* sp. was found

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

Foraging behavior/ spider families	Srinagar (335)			Budgam (353)			Anantnag (328)			Total (1016*) %
	Shalimar (108*) %	Dara (115*) %	Syedpora (112*) %	Khan sahib (126*) %	Arath (112*) %	Rajwan (115*) %	Kokarnag (109*) %	Khudwani (113*) %	Khanbalq (106*) %	
Orb-Web builders										
Araneidae	7.41	4.35	8.93	6.35	7.14	6.96	5.50	7.08	6.60	6.69
Tetragnathidae	12.96	12.17	9.82	6.35	8.04	6.96	10.09	8.85	8.49	9.25
Total	20.37	16.52	18.75	12.70	15.18	13.92	15.59	15.93	15.09	15.94
Space-Web builders										
Theridiidae	11.11	10.43	11.61	10.32	8.93	12.16	6.42	5.31	10.38	9.66
Linyphiidae	3.70	5.22	0.89	3.17	0.0	5.22	4.59	0.88	2.83	2.95
Total	14.81	15.65	12.50	13.49	8.93	17.38	11.01	6.19	13.21	12.61
Visual hunters										
Lycosidae	18.51	20.87	20.54	23.02	19.64	16.52	14.08	19.47	16.04	18.90
Salticidae	8.33	7.83	13.39	11.11	9.82	7.83	8.26	7.97	4.72	8.86
Oxyopidae	5.56	6.09	4.46	9.52	7.14	6.96	5.50	12.39	12.26	7.77
Gnaphosidae	5.56	11.31	6.25	5.56	8.93	6.96	9.17	12.39	5.66	7.97
Pisauridae	6.48	6.09	10.72	5.56	10.72	10.43	7.34	7.08	11.32	8.36
Sparassidae	3.70	1.72	0.89	3.17	2.68	0.87	1.84	0.88	2.83	2.07
Total	48.14	53.91	56.25	57.94	58.93	49.57	46.79	60.18	52.83	53.93
Tactile hunters										
Thomisidae	7.41	9.57	6.25	8.73	7.14	6.96	8.26	5.31	6.60	7.38
Clubionidae	4.63	4.35	3.57	5.56	5.36	12.17	10.09	4.42	1.89	5.81
Miturgidae	4.63	0.0	2.68	1.58	4.46	0.0	8.26	7.96	10.38	4.33
Total	16.66	13.92	12.50	15.87	16.96	19.13	26.61	17.70	18.87	17.52

*Numbers in parentheses are total spider numbers on which percentage are based

abundant species. Several alate aphids were frequently found in a single web and early instar lepidopterous Larvae, small flying insects, beetles, hoppers, white flies were also recorded from web.

Family-Linyphiidae Blackwall (Sheet-web or dwarf spider)

Most of the *Linyphiids* were live under dead leaves and debris. Poor population of *Linyphiids* was recorded among web building spiders and representing only 2.95% population. The highest population (5.22%) was recorded at Dara and Rajwan and the lowest at Khudwani (0.88%) (Table 2). They made sheet like or irregularly shaped web for preying insect. The principal part of the web consists of more or less closely woven sheet extended in a single plane with threads extending in all directions irregularly in that plane. These spiders largely depend upon their sheet webs to capture prey. The sheet web, which may or may not bear lines above it, is highly distinctive of family. Eggs are laid in masses on the foliage and covered by them sheet of web and receive no maternal care. *Lepthyphantes* sp. and *Eriogona rohtagensis* Tikader are representing to this family. Moths, beetles, hoppers, alate aphids and other small insect observed in webs.

Visual hunting spiders

Visual hunting spiders were representing 53.93% of total spiders collected during study (Table 3). Six families were recorded under visual hunting spiders are Lycosidae, Salticidae, Oxyopidae, Gnaphosidae, Pisauridae and Sparassidae.

Family-Lycosidae Sundevall (Wolf spider)

Among all groups of spiders it was most abundant spider family and represented 18.90% population of spiders and the highest population (23.02%) was recorded at Khan Sahib and the lowest at Kokarnag (14.68%). The eight eyes are distinctly dark, dark colour around eye; the abdomen is oval and usually not more bulky cephalothorax, not build web to catch prey. Egg sac were attached to spinnerets and young carried on mother's back. They lived in the lower part of the leaves. *Lycosids* are active searcher, nocturnal habit but also seen during day, hunter and ground dweller and well runner for searching the prey. Most are wanderers and few live in burrows. *Lycosa altitudis* Tikader and Malhotra, *Pardosa ladakhensis* Tikader and *Arctosa* sp. were recorded under this family and *L. altitudis* was found most abundant species. Nymph of grass hopper, aphids, white flies, moths, early instars lepidopterous

larvae, small beetles and early instar of spiderlings were preyed by this group of spiders.

Family-Salticidae Blackwall (Jumping spider)

The *Salticids* owe their acute to their enlarged middle eyes, making possible the cat-like way of catching prey which is characteristics of this group. First two pair of legs are large than last two pair for jumping. They represented 8.86% of total spiders collected during study and second position in abundant among all visual hunting spiders. The highest proportions of *Salticids* (13.39%) were recorded at Syedpora and the lowest at Khanbal (4.72%). They walk quickly, stalk and jump to get hold of the prey. Live on whole plant, spine cocoons in horizontal leaf for developing spiderlings. The jumping spiders are visually oriented, diurnal hunting spiders that search the foliage, stems and leaves for prey. Five species viz., *Phidippus* sp., *Marpissa* sp., *Myrmarachne* sp., *Myrmarachne himalayensis* Narayan and *Zygoballus* sp. were recorded under this family and *Myrmarachne* sp. was found most abundant species. They were feeding on hoppers, aphids, whiteflies, coccinellid larvae, and other small insect associated to maize plants.

Family-Oxyopidae Thorell (Lynx spider)

Long spines on legs and hexagon eye pattern are the main characteristics of this family. This diurnal hunting spider was common and representing 7.77% population of spiders. *Oxyopids* population (12.39%) was highest recorded at Khudwani location of district Anantnag and the lowest at Syedpora (4.46%) location of district Srinagar. They were move on plant and water surface, below shade and also on ground. They were highly adapted to jumping and climbing rapidly with jerky movements among stems and leaves. In movement they resemble the *Salticids*, but are more slender and even more active and cat like. No web is constructed; they are wanderers and obtain prey by stalking and pouncing. The egg-sac is laid upon the foliage, which are then covered by a sheet and mother usually mounts guard over the sac. Under this family two species are *Oxyopes ratane* Tikader and *Oxyopes javanus* (Thorell) were recorded. Hopper, aphids, white flies, moths, early instars lepidopterous larvae and spiderlings were preyed by this group of spiders.

Family-Gnaphosidae Pocock (Ground Spider)

They are hunter, ground dweller hide on cracks of soil. Hunting their prey over leaf letter on ground and

they take shelter in the holes, soil cracks, under the stones. These are predominantly ground dwelling spiders, nocturnal in habit, hunting by stealth. Ganaphosids spin delicate silken sacs, within which they moult or mate. These spiders were common and representing 7.97% population of spiders. The population represented the fourth position in abundance among visual hunters and the highest population (12.39%) was recorded at Khudwani location of district Anantnag and the lowest at Shalimar and Khan Sahib (5.56%) location of district Srinagar and Budgam, respectively. Two species of *Gnaphosid*, *Setaphis* sp. and *Zelotes* sp. was recorded in maize ecosystem. Moths, beetles, hoppers, aphids, lepidopterous larvae, and other insect coming on ground as well as lower plant part were captured by this group of spiders.

Family-Pisauridae Simon (Nursery web spider)

These are commonly found near water bodies or wet area of field. They were representing 8.36% of total spiders collected during study and third position in abundant among all visual hunting spiders. The maximum population of spider was recorded at rich water channel area at Khanbal (11.32%) of Anantnag district and the lowest at high altitude of Khan Sahib (5.56%) of district Budgam. Some species are found in open areas of grass and dwarf shrub while others are found along the edges of streams and ponds, where they fish for prey (Turnbull, 1973). Females carry egg sac in their chelicerae and not attached to the spinnerets. Nursery web spiders are active wanderers and not construct webs to catch the prey. They build the nursery web above the egg sac and guard it until spiderlings leave their egg sac. Unlike the lycosids, female pisaurids carry their egg cocoons in their chelicerae and not attached to the spinnerets. *Pisaura* sp. was recorded preying on beetles, aphids, larvae and insect of ground as well as lower part of maize plant.

Family-Sparassidae Bertkau (Huntsman or Giant Crab spider)

Huntsman spiders can generally be identified by their legs, which, rather than being jointed vertically relative to the body, are twisted such that the legs extend forward in a crab-like fashion. Many huntsman spiders are dull shades of brown or grey. Their legs are covered with fairly prominent spines, but the rest of their bodies appear smooth. They are frequently found in sheds, garages and other infrequently-disturbed places. As adults, huntsman spiders do not build webs, but hunt and forage for food: their diet consists primarily of insects and

other invertebrates, and occasionally small skinks and geckos. They live in the crevices of tree bark, but will frequently wander into homes and vehicles. They were found in folded leaves of maize plants. They are able to travel extremely fast, often using a springing jump while running, and walk on walls and even on ceilings. They also tend to exhibit a “cling” reflex if picked up, making them difficult to shake off and much more likely to bite. The females are fierce defenders of their egg sacs and young. *Sparassus* sp. carry their biscuit-shaped egg-sac underneath the body by clasping it with pedipalp. They will generally make a threat display if provoked, but if the warning is ignored they may attack and bite. Moths, beetles, lepidopterous larvae small spiders and their spiderlings preyed by this group of spiders. Under this family, *Sparassus* sp. and *Olios* sp. were recorded from maize ecosystem and this family representing lowest number (2.07%) of populations among all collecting spiders.

Tactile hunting spiders

Tactile hunting spiders were representing 17.32% of total spiders collected during study. Three families were recorded under visual hunting spiders are Thomisidae, Clubionidae and Miturgidae.

Family-Thomisidae Sundevall (Crab spider)

Crab like appearance and first two pairs of legs are robust and powerful. Powerful legs and spinos legs are used for seizing prey. They were not constructing webs but hunt by stealth and ambush. Mimics, slow mover, hunting, hide in flower or under side of leaves and wait for capture insects that visit them. This diurnal hunting spider was common and represented 7.38% population of spiders which was highest among tactile hunters. Among all locations of Kashmir, the highest population (9.57%) was recorded at Dara of district Srinagar and the lowest at Khudwani (5.31%) in district Anantnag. Among two species, *Thomisus* sp. and *Xysticus* sp. the last one was found abundant and preyed on flower visiting insects, aphids, white flies, and other small insect associated to the flower of the maize plants.

Family-Clubionidae Wagner (2-clawed or sac Spider)

Spiders construct a silken tubular sac, nocturnal in habitat, non-webber usually found to live in loose bark of plants, foliage of plant, leaves and under stone. Fold leaf first down then up for shelter and hide-out. Hunting their prey over leaf letter on ground and they

take shelter in the holes, soil cracks, under the stones. Female lay the yellowish egg mass in folded leaf and remain within till the egg hatched. This nocturnal tactile hunting spider was not more common but representing 5.83% population of spiders which was second highest among tactile hunters. Among all locations of Kashmir, the highest population (12.17%) was recorded at Rajwan location of district Budgam and the lowest at Khanbal (1.89%) location of district Anantnag. *Clubiona* sp. and *Clubiona japonicola* Boesenberg et were recorded from maize ecosystem and *Clubiona* sp. was found abundant species. Moths, beetles, aphids, lepidopterous larvae and insect passing to their sac (in which they hide for prey) was captured by *Clubionids*.

Family-Miturgidae Simon (Dark sac spiders)

Miturgids were representing 4.33% population of spiders which was the lowest among tactile hunters. The population of Miturgids was not recorded at Dara and Rajwan locations and the highest population was recorded in Khanbal (10.38%). Dark sac spiders were fast and aggressive, free ranging and nocturnal and commonly occur on vegetation. They are important in controlling small agricultural insect pests like aphids, mites, flies, early instar larvae etc. They live in low shrubs or under fallen logs or rocks. Hunting their prey over leaf litter on ground and they take shelter in the holes, soil cracks, under the stones. Only one species, *Cheiracanthium* sp. was recorded in maize ecosystem of Kashmir.

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