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Seasonal Diversity and Status of Spiders (Arachnida: Araneae) in Salbardi forest (Satpura Range), Maharashtra, India.

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Abstract
Present investigation reflects the spider population and diversity according to seasonal variation in the Salbardi forest, Satpura Range, District Amravati, Maharashtra, India. The investigation was carried out for 1 year from June 2012 to May 2013. Sampling was done for three seasons/year viz., monsoon, winter, summer. Spiders were collected in quadrants from different spots by various methods. Different indices were calculated using the Biodiversity pro software version 2. Spider population in different seasons exhibited variation in species abundance and composition. Consecutive survey for three seasons revealed occurrence of 104 species belonging to 18 families. Of these Salticids were predominant (19.23 %) and Aranidae contributed 18.26%. Shannon index, Simpson index, and Margalef Richness index evaluated were 1.06, 0.103 and 8.4 respectively. Spiders belonging to different feeding guild and population were higher during monsoon and winter season. The study suggests influence of seasonal variations on occurrence and diversity of spiders in Salbardi forest.

Keywords: spiders, diversity, seasonal variations, Salbardi forest.

1. Introduction
Spiders are generalist feeders with great species richness in every type of terrestrial habitat and play an important role in the structure of communities and food webs, both as a individual numbers and as energy consumers [8]. Spiders acting as ecological indicator, are cosmopolitan in distribution and locally abundant in terms of individuals and taxa. Their small body size allows them to maintain their community in small area. Spiders are insectivorous animal and insect fauna changes with the change in vegetation. Vegetation structure may vary according to seasonal variation throughout the year. In Salbardi forest seasonal variation may be an important factor for spider diversity.

Spiders play a significant ecological role by being exclusively predatory and thereby maintaining ecological equilibrium. Spiders in protected areas of India are studied by Gajbe in Indravati Tiger Reserve, who recorded 13 species [9]. Rane and Singh recorded five species [19] and Gajbe [10] recorded 14 species from Kanha Tiger Reserve, Madhya Pradesh. Gajbe also prepared a checklist of 186 species of spiders in 69 genera under 24 families distributed in Madhya Pradesh and Chhattisgarh [11]. Patel described 91 species belonging to 53 genera from Parabikulum Wildlife Sanctuary, Kerala [17]. Manju Silwal recorded 116 species from 66 genera and 25 families of spiders from Purna wildlife Sanctuary, Dangs, Gujarat [14]. Bastawade described arachnid fauna of orders Araneae, Scorpionida and Solifugi from Melghat Tiger Reserve, Amravati, Maharashtra State [2]. Hippargi, reported occurrence of spiders from 19, 25, 31families from Lonar, Melghat and Southern Tropical thorn forest, Solapur respectively [13]. Deshmukh and Raut [5] recorded 57 species belonging 35 genera under 14 families during 6 month survey in Salbardi forest (Satpura range).

Spiders can be arranged in to different guild based on similarity in their methods of acquiring food. Availability of prey density determines the diversity of spiders. Prey density is mainly based on seasonal variation and vegetation structure which may keep changing throughout the year in turn affecting spider diversity and abundance. Thus the study was planned with the objective to determine seasonal changes in spiders community membership as there is absence of any relative work report from this area or even in India.

2. Material and methods

2.1 Study area

The present study was conducted from June 2012 to May 2013 at Salbardi forest (Satpura range) with geographical location between East longitudes Coordinates: 21°25'23"N 78°0'55"E. It is about 8 km. (5 miles) north of Morshi, District Amravati, on the border lying partly in the Betul District of Madhya Pradesh on Madu River. Salbardi is named from its abundance of 'Sal' trees and the stony character of its soil. The vegetation mainly consisted of *Lantana camara, Acacia leucophloea, Aegle marmelos, Annona squamosa, Butea monosperma* etc. The temperature in the area varied from 18 ^{0}C to 40 ^{0}C. The region receives an annual rainfall of 900 mm during the southwest monsoon between June and September. The relative humidity varied from 30 to 80 %. The study area was divided in to total five different habitats to study the diversity of spiders.

2.2 Sample collection

Sampling was carried out at each habitat at an interval of 7 days. In order to have adequate samples of spiders from various habitats, a wide variety of collection and trapping methods were used, i.e. walk through the habitat and visual search for spiders, their webs or retreats (curled leaves, silken leaves), sweeping, beating, pitfall trapping etc. The collected spiders were photographed, sorted and preserved in labeled insect collecting bottles containing 70% alcohol. Collected spiders were identified using standard identification keys of Barrion and Litsinger [1], Biswas and Biswas [3], Davies and Zabka [4], Gajbe [11], Plantnick [18], and Tikader [24, 25, 26, 27].

2.3 Data analysis

The diversity of spiders was analyzed by widely used indices viz., The Shannon –Wiener index (H^1), which is sensitive to changes in the abundance of rare species in community and the Simpson index (λ), which is sensitive to changes in the most abundant species in a community, and Margalef Richness which were calculated using biodiversity pro software version 2.

3. Results

A total of 1874 individuals belonging to104 species, 52 genera and 18 families were collected during the study (Table no. 1). Amongst the families the Salticidae was the most abundant (19.23%) followed by Aranidae (18.26%), Thomisidae (12.05%), Oxyopidae (8.65%), Lycosidae (7.69%), Gnaphosidae (6.73%), Philodromidae (4.76%), Eresidae (3.84%), Tetragnathidae (3.84%), Pholcidae (2.88%), Theridiidae (2.88%), Clubionidae (1.92%) and Uloboridae (1.92%). The least species diversity was recorded in the families in Hersilidae, Miturgidae, Nephilidae, Scytodidae and Sparacidae with (0.96%) in each family, abundantly found for restricted period (Fig. 2). Out of the 104 species classified, 41 species were 'very common', 29 species 'common', 22 species 'rare' and 12 species 'very rare'. (Table 1)

Spiders exhibited seasonal variation in their occurrence. A total of 30 species were recorded during Monsoon season (June, July, August, September); 60 species during winter (October, November, December, January); 14 species during summer (February, March, April, May). However 10 species were recorded throughout the year. (Table 2). %. Shannon index, Simpson index, and Margalef Richness index evaluated were 1.06, 0.103 and 8.4 respectively. (Table 3).

4. Discussion

Several workers suggested that spiders remain active during winter, often have definite types of life cycles and certain overwintering stages [7, 15, 22, 23]. To verify this in part, the study was framed to determine the family composition and species abundance of spiders in different seasons in Salbardi forest throughout the year. Family composition of the spiders community shows considerable variability from month to month. Salticidae represent the dominant family for most of the months because it feeds on nymphs, larvae and insects whatever available throughout the year. It is interesting to note that, the highest numbers of spiders were collected in winter and greatest numbers of species were also reported as compared to monsoon and summer, whereas least number was recorded in summer.

After the onset of rainy season various seasonal plants starts to flourish and attracts large number of insect fauna. During this period maximum families of spiders were observed, mainly with abundance of *Leucage decorata*, *Hippasa pisaurina* and *Hippasa holmerae* etc. This coincides with the observation of other researchers on grasslands who demonstrated that spiders respond numerically to the diversity and complexity of the vegetation [12, 21].

Monthly fluctuation in their activity is mainly influenced by the activity of males, when mature male becomes active in the effort to find mates. Therefore, the increased number in collection is indicative of the time of reproduction [6, 16, 28] similar observations were recorded in our study, mature male of genus Oxyopus were abundant during last week of August and egg sacs of the same were observed during September.

During winter large numbers of species were recorded in the study area. *Cyclosa simon*, *Cyclosa moonduensis* and *Cyclosa hexatuberculata* were most abundantly found. They were living together on the patches of vegetation of *Annona squamosa*. Thomisidae, Therediidae, Uloboridae were also abundantly recorded in winter. Thomisus commonly known as flowering spiders, they feed on the insect visiting flowers, Male and female of this family were also recorded during winter and egg sacs were observed during late winter. The kleptoparasite, *Argyrodes* species do not build their own webs but steal prey from the host's web like orb webs of some Araneids, crenellate orb webs of *Uloborus* and even on the webs of *Nephila Philip* in October and November respectively. *Argyrodes* species feeds on insects which are trapped in the host's web. Hersilidae species were abundant in the restricted period of year during the month of October on the bark of tree. Mature male and females of family *Eresidae* genus *Stegodyphus* were observed during October, mating was recorded in November and egg sacs in December to January. Spiderlings hatches in February but with increasing temperature they hide up and recurrence was recorded after sufficient rain fall.

As rainy season starts certain species like e.g. *Neoscona, Cyclosa, Thomisus* etc. start to appear. According to Duffey it is well known that denser the vegetation greater is the density of young spiders and greater the diversity of vegetation the greater is the spiders species diversity [6]. Most orb web spiders rest at the hub of the orb during the day and are susceptible to heating and desiccation. Larger orb weavers, such as *N. clavipes*, exhibit behavioral thermoregulation when exposed to direct sunlight [20]. Same observations were recorded in the Salbardi forest, it has been also observed that orb weaving spiders start to construct their webs in the evening and selfdestruct them by morning.

Nephila pilipes were abundantly recorded resting on webs in winter particularly females at the centre and two to three males on same web but at the periphery, but after the onset of summer may be due to rise in temperature they hide up in shadow/colder places. Small orb weaver, however, would be prone to desiccation due to greater surface volume ratio. Webs of orb weaver are generally fragile (With the exception of Nephila) and may be easily damaged or destroyed by falling leaves and branches. Dust and fallen leaves covers the viscid spirals of webs and reduce their effectiveness. These factors may be partly responsible for the decrease in abundance of orb webs during the summer season but those species which live inside the leaf litters were abundant during summer e.g., *Gnaphosa*, *zelotes*, *Sosticus* etc. The sheet-web builders, Pholcids and some members of Salticidae occurred throughout the year. Spiders are generalist predators and are more likely to be influenced by seasonal changes.

Table 1: Genera and species distribution of spiders in Salbardi forest.

S. No.	Family	Genera	Species	No. of Ind.	Status				Season
					VC	C	R	VR	
1	Araneidae	8	19	50	6	4	7	2	MWS
2	Clubionidae	1	2	10	0	0	0	2	W
3	Eresidae	1	4	20	4	0	0	0	WS
4	Gnaphosidae	5	7	20	0	4	3	0	MWS
5	Hersiliidae	1	1	05	0	1	0	0	W
6	Lycosidae	3	8	25	2	2	3	1	MWS
7	Miturgidae	1	1	05	0	1	0	0	W
8	Nephilidae	1	1	05	1	0	0	0	MW
9	Oxyopidae	2	9	20	6	0	3	0	MW
10	Philodromidae	4	5	20	2	2	1	0	MW
11	Pholcidae	1	3	20	3	0	0	0	MWS
12	Salticidae	11	20	50	10	6	2	2	MWS
13	Scytodidae	1	1	05	0	0	0	1	W
14	Sparacidae	1	1	05	0	0	0	1	W
15	Tetragnathidae	2	4	10	2	2	0	0	MW
16	Thomisidae	6	13	30	5	3	2	3	MWS
17	Theridiidae	2	3	10	0	2	1	0	W
18	Uloboridae	1	2	05	0	2	0	0	W
	Total	52	104	310	41	29	22	12	

VC- Very common, C- Common, R- Rare, VR-Very rare.
M- Monsoon (June, July, August, September)
W- Winter (October, November, December, January)
S- Summer (February, March, April, May)

Table 2: Seasonal occurrence of spiders from Salbardi forest.

Sr. No.	Season	No. of spider species
1	Monsoon (June, July, August, September)	30
2	Winter (October, November, December, January)	60
3	Summer (February, March, April, May)	14
4	Throughout the year	10

Table 3: Diversity indices of spiders in Salbardi forest.

Sr. No.	Diversity indices	Salbardi forest
1	Shannon index H	1.06
2	Simpson index λ	0.10
3	Margalef Richness Index R	8.42

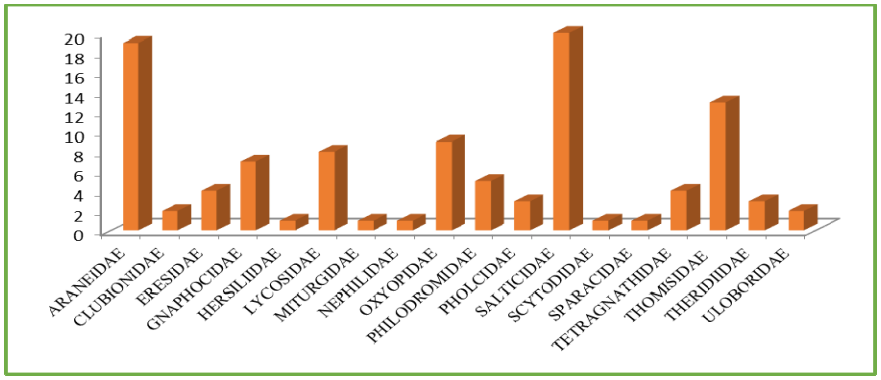

Fig 1: Family wise distribution of spiders in Salbardi forest.

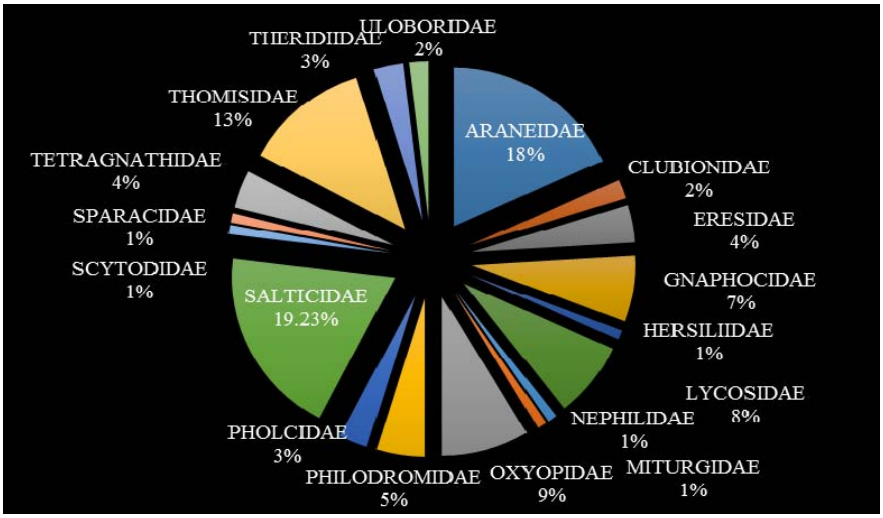

Fig 2: Dominant spider families on an annual scale.

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