IOSR Journal Of Pharmacy
(e)-ISSN: 2250-3013, (p)-ISSN: 2319-4219
Volume 12, Issue 3 Series. I (March 2022), PP. 47-53
www.iosrphr.org

Species Composition, Density, Abundance and Percent Occurrence of Spiders at Three Different Sites of Mysore City, Karnataka

NIJAGAL B.S*, S PADMA, ANJU MICHAEL and LORITA D'SOUZA
Postgraduate Department of Zoology, JSS college of Arts commerce and Science,
Ooty road, Mysore – 570 025, Karnataka, India

ABSTRACT: *Field survey on Spider species composition, density, abundance and percent occurrence was conducted in three selected sites of Mysore city during January to April, 2019 using active searching, beating, leaf sampling and net sweeping techniques. A total of 1,210 individuals of 105 species belonging to 22 families were recorded. The Salticidae was the most dominant family having highest number of species recorded (25.71%), followed by Araneidae (20.95%), Theridiidae (10.47%), Oxyopidae and Uloboridae (6.6% each), Tetragnathidae, Sparassidae and Thomisidae (3.8% each), Lycosidae and Philodromidae (2.85% each), Linyphiidae and Pholicidae (1.90% each) and families Cheiracanthiidae, Corrinidae, Clubionidae, Dictynidae, Gnaphosidae, Hersilidae, Liocarnidae, Platoridae, Pisuaridae and Sicariidae with one species each (0.95%). Statistical analysis was done to understand variation in distribution of spider species by applying appropriate diversity indices in different study sites. The result showed that species richness and density was highest in the site-2 (Karanji lake) which can be attributed to the high diversity of plants and availability of resources and favourable habitat structure compared to site-1 (JSS college campus) and site-3 (Kesare Farm house).*

Key words: *Arachnida, Araneae, Spider Diversity, Mysore city.*

I. Introduction

Spiders are one of the most fascinating and diverse groups of organisms belonging to the largest order Araneae of the Class Arachnida and Phylum Arthropoda. Order Araneae rank seventh in total species diversity among other orders of animal kingdom (Coddington, 2005). The global list of spider fauna is approximately 48,345 species belonging to 4,149 genera and 120 families (Platnick, 2019). The first comprehensive list of Indian spiders which included 1,067 species belonging to 249 genera in 43 families was published by Tikader (1987). Keswani et al. (2012) documented 1,685 spider species belonging to 439 genera under 60 families in India. Spiders are characterized by high taxonomic diversity and guild responses to environmental change, intensely sensitive to small changes in habitat structure, including vegetation complexity, litter depth and microclimate characteristics (Uetz, 1991). Spiders are generalist predators in terrestrial ecosystems that are highly influenced by changes in plant community structure (Avila et al. 2017). This ubiquity, diversity and ecological role of spiders makes them an excellent bio-indicators of ecosystem management practices (Pearce & Venier, 2006). Spiders also play an important role in balancing the food chain and ecosystem (Charles & Hall, 1982). The aim of the present study was to record the species composition, density, abundance and percent occurrence of spider species at three different sites of Mysore city. This study may help in developing awareness about spiders in general public, their role in ecological balance as biocontrol agents.

II. Materials And Methods

Present study was conducted from January to April, 2019 in three different sites of Mysore city ($11^{0}30^{1}$-$13^{0}04^{1}$ N $75^{0}45^{1}$-$77^{0}45^{1}$E). Study sites were selected based on the landscape, floral diversity and anthropological interference. Site-1 (JSS College campus, $12^{0}17^{1}11^{11}$N $76^{0}39^{1}35^{11}$E) is rich in vegetation such as trees, shrubs, herbs and creepers. However, the campus is prone to inevitable anthropological activities, whereas site-2 (Karanji Lake, $12^{0}18^{1}10^{11}$ N and $76^{0}40^{1}24^{11}$ E) is diverse with flora and a beautiful lake attracting migratory birds, water fowls and regular tourists. The shoreline is surrounded by marshy areas with wild grass species, thick bushes, herbs and shrubs which attract many pollinators. It is surrounded by a nature park consisting of a butterfly park and a walk-through aviary. Site-3 (Old Kesare farm house, $12^{0}21^{1}30^{11}$N $76^{0}40^{1}13^{11}$E) is situated on a sprawling 4 acres of plot with thick vegetation distribution with Cow shed and Poultry farm (Fig 1). The temperature in the study sites ranged from 28°C – 36°C, Humidity 46 -53% with moderate rainfall conditions.

Spiders from the trees, shrubs and ground were collected by adopting standard sampling techniques such as Active Searching and Hand Picking Method as per Ganesan and Shunmugavelu, 2012 and Varsha and Narendra, 2016. Species identification were carried out based on Visual observation and Photographs recorded and based on the morphological characteristics using key features as per Tikader, 1987, www.spiderid.com, World Spider Catalog, World Wide Database of Jumping spiders and scientific research articles.

Guild Classification

Ecological characteristics relating to foraging manner, nature of web, prey species, microhabitat use, site tenacity and daily activity were subjected to guild classification. Depending upon the foraging strategies of spiders, they have been categorized into eight different ecological guild structures namely, Stalkers, Ambushers, Foliage runners, Ground runners, Sheet web-builders, Tangle web weavers, Orb web weavers and Space web-builders (Sudhikumar *et al*., 2005). Output of the analysis was organized into tabular form. The spider guild classification was composed according to the families observed during the study. Spiders families used in the determination of guilds were those linked in the review of Uetz *et al*., (1999), Krishna and Priyanka (2015), Sebastian *et al*., (2017) and others.

Statistical analysis

Information on spider species distribution, number of individuals, web structure was studied. Collected data was statistically analyzed using PAST 4.0 software for diversity, density, abundance and percentage.

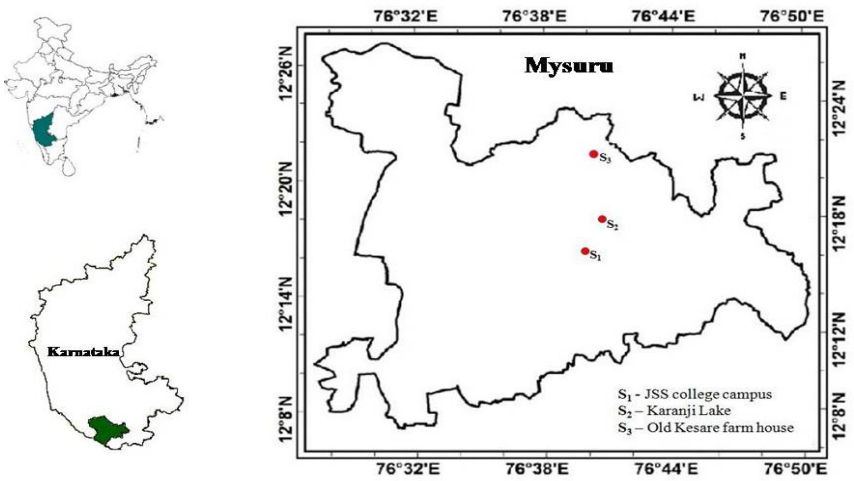


Fig 1: Map showing the study sites in Mysore, Karnataka

III. Result

In the present study, a total of 22 families (Table.1) were recorded in all the three study sites out of which Site-1 was recorded with 14 families while site-2 with 21 families and site-3 composed of spider species from 14 families (Fig.2). Families such as Araneidae, Salticidae, Theridiidae, Lycosidae, Philodromidae, Pholicidae, Sparassidae, Amaurobiidae, Hersilidae, Oxyopidae and Thomisidae were recorded in all the three study sites whereas spider species from Linyphiidae and Miturgidae families were found in site-1 and 2, on the contrary Tetragnathidae family members were recorded in site-2 and 3. A representative species of Sicariidae family (*Loxosceles recluse)* was recorded only in site-3. Percentage distribution of families in three study sites is depicted in Fig.2.

Out of 105 species recorded, family Salticidae was found to be dominant with 27 species (25.71%) of spiders, followed by Araneidae - 22 species (20.95%), Theridiidae - 11 species (10.48%), Oxyopidae and Uloboridae - 7species (6.67%), Sparassidae, Tetragnathidae and Thomisidae - 4species (3.81%), Lycosidae - 3 species (2.86%) and Linyphiidae, Philodromidae and Pholicidae - 2 species (1.90%) and remaining families such as Cheiracanthiidae, Corrinidae, Clubionidae, Dictynidae, Gnaphosidae, Hersilidae, Liocranidae, Platoridae, Pisuaridae and Sicariidae were represented by single species each (0.95%) (Fig 3).

Different diversity indices were calculated to study the community structures of spiders at three different ecosystems (Table 2 and 3). Shannon- Wiener index is greater in site-2 (3.267) indicating increased diversity and also stable and balanced habitat structure. Evenness varied between 0.719 - 0.726. It indicates that the distribution of spider species between the ecosystems is almost similar. Further, species richness in site-2

was 14.03 while that of site-1 and site-3 was 6.405 and 5.023 respectively indicating high species richness in site-2when compared to other two study sites. Sorenson's diversity also showed the same trend.

Guild composition

Observation on spider guild composition revealed seven different foraging guilds i.e., Orb web weavers, stalkers, ground runners, space web builders (includes irregular web and tangled web), sheet web builders, foliage runners, and ambushers (Fig 3). In the present study, the stalkers was predominant (33%) followed by orb web builders (31%), tangled web (10%), ambushers (8%), foliage runner (7%), ground runners (5%), sheet web (3%), irregular web (2%) and funnel web (1%). (Fig 4).

Table 1: Checklist of Spider species in different study sites

Sl. No.	GENUS/SPECIES	Site-1	Site-2	Site-3
I	**Araneidae**			
1.	*Gastercantha geminate* (Fabricius, 1798)	+	+	+
2.	*Cytrophora cicatrosa* (Stoliczka,1869)	+	+	+
3.	*Cytrophora citricola* (Forsskal, 1775)	+	+	-
4.	*Argiope argentata* (Fabricus, 1775)	+	+	+
5.	*Argiope anasuja* (Thorell, 1887)	-	+	-
6.	*Argiope aemula* (Walckenaer,1841)	+	+	-
7.	*Argiope pulchella* (Thorell, 1881)	-	-	+
8.	*Argiope catenulata* (Doleschall, 1859)	-	+	-
9.	*Argiope* sp *1*	-	+	-
10.	*Argiope* sp *2*	+	-	-
11.	*Argiope* sp *3*	+	-	-
12.	*Parawixia dehaani* (Doleschall, 1859)	-	+	-
13.	*Cyclosa bifida* (Doleschall, 1859)	+	+	-
14.	*Cyclosa insulana* (Costa, 1834)	+	+	+
15.	*Cyclosa moonduensis* (Tikander, 1963)	-	+	-
16.	*Cyclosa* sp.	-	+	-
17.	*Neoscona* sp.	-	+	-
18.	*Neoscona nautica* (L.Koch, 1875)	+	-	-
19.	*Neoscona crucifera* (Lucas, 1839)	-	-	+
20.	*Neoscona bengalensis* (Tikander & Bal, 1981)	+	+	-
21.	*Gea subarmata* (Thorell, 1890)	-	+	-
22.	*Eriovixia excelsa* (Simon, 1889)	-	+	-
II	**Cheiracanthiidae**			
23.	*Cheiracanthium melanostomum* (Thorell, 1895)	+	+	-
III	**Corrinidae**			
24.	*Castianeira zetes* (Simon, 1897)	-	+	-
IV	**Clubionidae**			
25.	*Matidia* sp.	-	+	-
V	**Dictynidae**			
26.	*Nigma puella* (Simon, 1870)	-	+	-
VI	**Gnaphosidae**			
27.	*Gnaphosa sericata* (L.Koch, 1866)	-	+	-
VII	**Hersilidae**			
28.	*Hersilia savignyi*(lucas,1836)	+	+	+
VIII	**Linyphiidae**			
29.	*Neriene emphana* (Walckenaer 1842)	-	+	-
30.	*Linyphia triangularis* (Clerck, 1757)	+	+	-
IX	**Liocranidae**			
31.	*Oedignatha andamanensis* (Deeleman- Reinhold, 2001)	+	+	+
X	**Lycosidae**			
32.	*Hippasa agelenoides* (Simon,1884)	+	+	+
33.	*Paradosa pseudoannulata* (Bosenberg & Strand, 1906)	+	+	+
34.	*Paradosa* sp.	-	+	-
XI	**Oxyopidae**			
35.	*Oxyopes macilentus* (L.Koch,1878)	+	+	-
36.	*Oxyopes shweta* (Tikader, 1970)	-	+	-
37.	*Oxyopes javanus* (Thorell, 1887)	-	+	+
38.	*Oxyopes lineatipes* (C.l.Koch, 1847)	-	+	-
39.	*Oxyopes* sp.	-	+	-
40.	*Peucetia viridians* (Hentz,1832)	-	+	-
41.	*Hamadruas* sp.	-	+	-
XII	**Platoridae**			
42.	*Psellonus* sp.	-	+	-
XIII	**Philodromidae**			

43.	*Philodromus* sp.	-	+	-
44.	*Tibellus elongatus* (Tikander,1960)	+	-	-
XIV	**Pholicidae**			
45.	*Pholcus phalangiodes* (Fuesslin,1775)	+	+	+
46.	*Crossopriza iyoni* (Blackwall, 1867)	+	+	-
XV	**Pisuaridae**			
47.	*Pisuara* sp.	+	+	+.
XVI	**Salticidae**			
48.	*Chrysille volupe* (Karsch, 1757)	-	+	-
49.	*Brettus cingulatus* (Thorell, 1895)	-	+	-
50.	*Telomania dimidiate* (Simon, 1899)	+	+	+
51.	*Telomania festiva* (Thorell, 1887)	-	+	-
52.	*Telomania* sp.	-	+	-
53.	*Portia fimbriata* (Doleschall, 1859)	-	+	+
54.	*Portia albimana* (Simon, 1900)	-	+	-
55.	*Phintella vittatan* (C.L.Koch, 1846)	-	+	-
56.	*Epocilla aurantiacia (Simon, 1885)*	-	+	+
57.	*Epeus flavobilineatus* (Doleschall, 1859)	-	+	-
58.	*Epeus indicus* (Proszynski, 1992)	-	+	-
59.	*Menemerus bivittatus* (Dufour, 1831)	-	+	+
60.	*Menemerus semilimbatus* (Hahn,1829)	+	-	-
61.	*Myrmarachne plataleiodes* (O.P.Cambridge, 1869)	+	+	-
62.	*Plexippus petersi* (Karsch, 1878)	+	+	+
63.	*Plexippus paykuli* (Audouin, 1826)	-	+	+
64.	*Hyllus semicupreus* (Simon,1885)	+	+	-
65.	*Rhene sp.*	-	+	-
66.	*Hasarius adansoni* (Audouin, 1826)	-	+	-
67.	*Phintelloides versicolour* (C.L.Koch 1846)	-	+	-
68.	*Colons hesperus* (Richman & Vetter, 2004)	-	+	-
69.	*Colons* sp.	-	+	-
70.	*Carrhotus viduus* (C.L.Koch, 1846)	+	+	-
71.	*Carrhotus* sp.	-	+	-
72.	*Hyllus* sp.	-	+	+
73.	*Bianor* sp.	-	+	-
74.	*Phidippus otiossus* (Hentz, 1846)	+	-	-
XVII	**Sicariidae**			
75.	*Loxosceles recluse* (Gertsch & Mulaik, 1940)	-	-	+
XVIII	**Sparassidae**			
76.	*Heteropoda venatoria* (Linnaeus, 1767)	+	+	+
77.	*Halconia insignis* (Thorell, 1836)	-	+	-
78.	*Martensopoda* sp 1	+	+	-
79.	*Martensopoda* sp 2.	-	+	-
XIX	**Tetragnathidae**			
80.	*Tetragnatha maxillosa* (Thorell, 1895)	-	+	-
81.	*Tetragnatha viridis* (Walckenaer, 1841)	-	+	-
82.	*Tetragnatha* sp1	-	+	+
83.	*Tetragnatha* sp2		-	+
XX	**Theridiidae**			
84.	*Achaeranea lunata* (Clerk, 1757)	+	+	+
85.	*Achaeranea mundula* (Koch, 1872)	+	+	+
86.	*Parasteotoda decorate* (L.Koch, 1867)	-	+	-
87.	*Argyodes elevates*(Simon, 1864)	-	+	-
88.	*Nesicodes rufipes*(lucas,1846)	+	+	-
89.	*Parasteotoda* sp.	-	+	-
90.	*Parasteatoda tabulate* (Levi, 1980)	-	+	-
91.	*Parasteotoda* sp 1	-	+	-
92.	*Parasteotoda* sp 2	-	+	-
93.	*Steotoda* sp.	-	+	-
94.	*Meotipa sahyadri* (Kulkarni, 2017)	-	+	-
XXI	**Thomisidae**			
95.	*Thomisus spectabilis* (Doeschall, 1859)	-	+	+
96.	*Thomisus* sp.	-	+	-
97.	*Indoxysticus minutus* (Tikader,1960)	-	+	-
98.	*Misumena vatia* (Clerck, 1757)	+	-	-
XXII	**Uloboridae**			
99.	*Zosis geniculatus*(Costa, 1834)	+	+	-
100.	*Uloborous plumipes*(Lucas, 1846	-	+	-
101.	*Uloborous glomosus* (Walckenaer, 1841))	+	+	-
102.	*Uloborous krishnae* (Tikader, 1970)	-	+	-
103.	*Uloborous divesus* (Marx, 1898)	-	+	-

104.	*Uloborus* sp *1*	-	+	-
105.	*Uloborus* sp *2*	-	+	-

Table No. 2: Results of Alpha(α) diversity indices

Diversity index	Study area		
	JSS Campus	Karanji lake	Old Kesare farm
Taxa-S	37	94	27
Individuals	276	757	177
Dominance D	0.2862	0.2708	0.2542
Shannon H	2.623	3.267	2.388
Evenness E	0.726	0.719	0.724
Margalef Species Richness	6.405	14.03	5.023

Table No. 3: Beta diversity (β) (Sorenson's index)

Study area	Site-1	Site-2	Site-3
Site-1	-	**0.4580**	**0.4687**
Site-2	**0.4580**	-	**0.3801**
Site-3	**0.4687**	**0.3801**	-

Fig 2: Percentage distribution of Spider families in the study sites

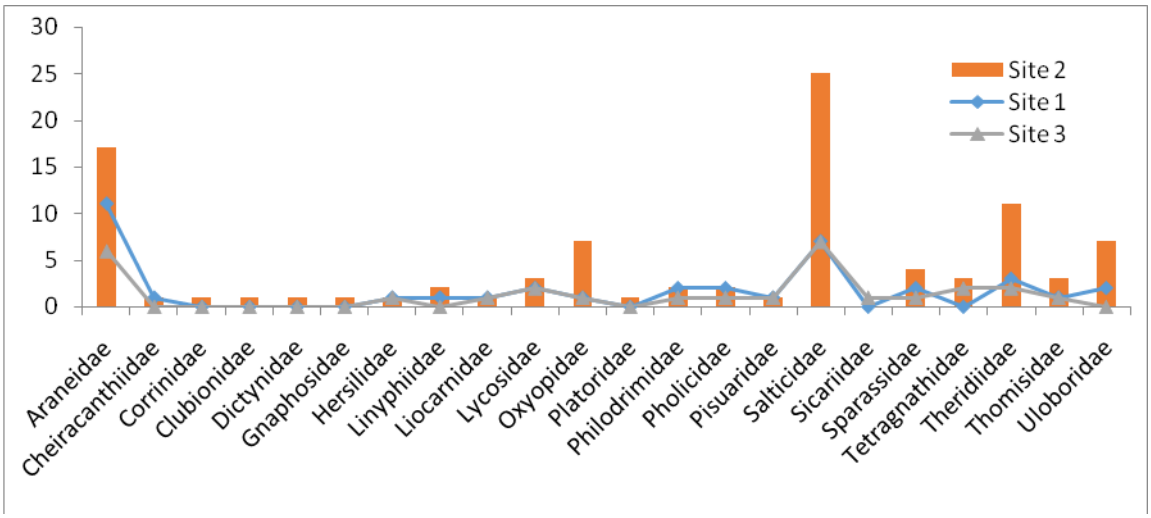


Fig 3: Overall distribution of Spider families in the study sites

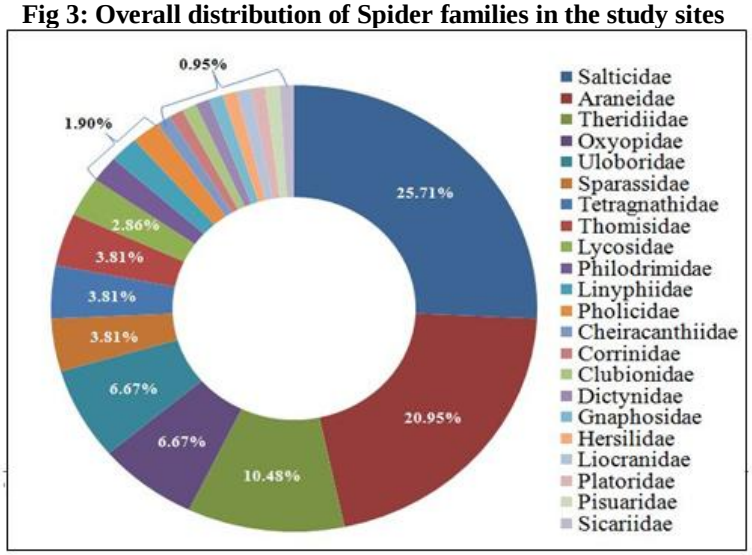
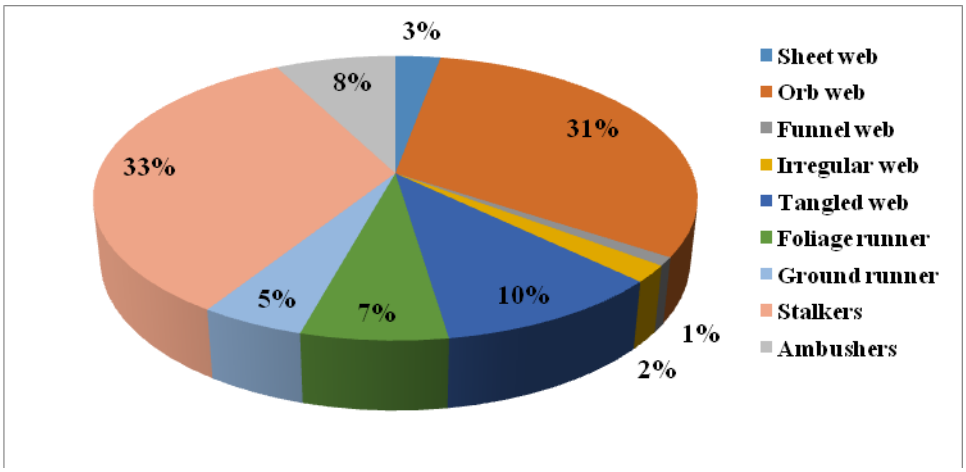


Fig 4: Occurrences of Spider Guilds in the study area (in percentage)



IV. Discussion

Keswani *et al.* (2012) reported 1686 species under 60 families in India. In the present study a total of 1210 individuals belonging to 105 species, 66 genera under 21 families (Table 1) were identified which corresponds to 9.37% and 35% of the total species and families respectively found in India. The species diversity in a given geographical area is affected by climatic factors, seasonality, spatial heterogeneity, competition, predation, habitat type, availability of resources, environmental stability and productivity. In the present study, the difference in distribution of spider species among three sites may be attributed to the factors mentioned above which change the vegetation structure, micro-ecological niche spatially and temporally (Sudhikumar *et al.* 2005). Site-2 had highest distribution of spider species illustrating availability of favorable conditions for the existence of spiders, whereas site-1 is an academic institute, neatly maintained habitat which experiences more human interference, predatory disturbance and habitat destruction. Thus, in site-1 Pholicidae family dominated. On the contrary, in site-3 the total number of spider families observed was less when compared to site-1and 2. Site-3 is dominated with dry deciduous trees, less grass on ground stratum. Further, well maintained plantation and poultry might have lead to a significant habitat loss which in turn might have affected the availability of resources for the survival of spider population when compared to other two study sites. Since Spiders are extremely sensitive to small changes in the habitat structure, habitat complexity and microclimate characteristics (Downie *et al.* 1999 and New, 1999) their abundance and distribution may vary from one geographical area to another.

Spiders establish different type of guilds. It is a species specific activity, influenced by foraging behavior and also ecological factors such as availability of prey species, microhabitat and daily activities. Majority of spiders are predators (Riechert and Gillespie, 1986) and obligate carnivores which feed on insects, other small arthropods and even other spider species. All the wandering spiders are hunters where they jump on the prey except Philodromidae, Sicariidae and Thomisidae which are ambushers. The leaves falling to the floor is the suitable habitat for ground runners. The deep leaf litter provides suitable hiding space to hunt and to avoid the extreme temperature. The differences in the physical structure of leaf litter and its complexity may also influence the species composition. Spider abundance and diversity is directly correlated with increased litter depth (Uetz *et al.* 1999). Araneidae, Tetragnathidae and Uloboridae construct perfect orb web, some Araneidae spiders such as *C. cicatrosa* and *C. citricola* show modified form of orb web called Dome tent web. Lycosidae members like *Hippasa agelenoides* build funnel web hiding inside the grass and wait for the prey. Members like Pholicidae and Theriididae weave scattered lines or irregular webs for prey capture. Amaurobiidae and Linyphiidae make sheet web. Patterns of spider guild structure observed may be effects of the flora, including its structural diversity, microenvironment, or the level of disturbance (Luczak 1979; Young & Edwards 1990).

V. Conclusion

The dominant family was found to be Salticidae contributing 25.71% of the total species recorded. Present study updates the checklist of spiders in the selected study area which exhibits good number of spiders and remarkable diversity in guilds.

Acknowledgement

Our special thanks to the Dr. Sudhikumar Ambalaparambil.K, Department of Zoology, Centre for Animal Taxonomy and Ecology, Christ College, Irinjalakuda, Kerala and Dr. Prashanthkumar.S.M, Department of Applied Zoology, Kuvempu University, Shimoga for their valuable guidance in identification of spider specimens.

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