Research Article

Spider Diversity (Arachnida: Araneae) in Different Ecosystems of the Western Ghats, Wayanad Region, India

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Abstract |Spiders are key components of all ecosystems in which they live and considered to be useful indicators of the overall species richness and health of terrestrial communities. However, spiders of the Western Ghats are poorly explored group and detailed information about their systematics, diversity and ecology is scarce. The present study is an attempt to investigate the spider faunal diversity in the selected habitats in the Western Ghats of North Wayanad region, Kerala, India. A total of 150 species belonging to 73 genera under 20 families were recorded from the selected habitats. Kartikulam forest reserve (Site D) showed the highest species richness and lowest species richness was recorded from Mananthavady region (Site A). Guild structure analysis of the collected spiders revealed seven functional groups viz. stalkers, orb-web builders, ambushers, space-web builder, ground runners, foliage runners and sheet-web builders. To conclude, the highest species richness is correlated with flora and fauna in these sites. The knowledge generated from the present study gives valuable and updated information on diversity of species of Western Ghats and the data can be used for future research on spider fauna.

Keywords: Forest Habitat, Plantations, Riparian Ecosystem, Species Richness, Spider, Western Ghats

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INTRODUCTION

Spiders are a diverse group of terrestrial predators, although generalizations about habitat use by spiders are complicated by their wide diversity in foraging strategies (Goldsbrough et al., 2004). They form one of the ubiquitous groups of predaceous organisms in the Animal Kingdom (Raiz et al., 2018). They can be used as successful biological indicators to assess the ecosystem health as they can be easily identified and are differently responsive to natural and anthropogenic disturbances (Pearce and Venier, 2006). This is the most diverse, female dominated and entirely predatory order in the arthropod world. Evidently, they are key components of all ecosystems in which they live (Bennett, 2001). As spiders are general predators, they are of immense economic importance to man because of their ability to suppress pest abundance in agro-ecosystems. The population densities and species abundance of spider communities in agricultural fields can be as high as that in natural ecosystems (Mathew et al., 2014). In spite of this, they have not been treated as an important biological control agent, since very little is known of the ecological role of spiders in pest control (Fahad et al., 2015). There is a growing concern over the adverse effects of agricultural intensification on biodiversity in agricultural areas (Swift et al., 1996; Krebs et al., 1999). Despite their size, the ecological importance of spiders is undeniable as they are abundant predators of other forest arthropods (Scharff et al., 2003). Spiders are one of the most varied and functionally important predators regulating the terrestrial arthropod population, thereby, making them effective biological control agents in ecosystems. Thus their high abundance and high diversity in almost all microhabitats, and foraging strategies coupled with the advantage of easy collection allow for their effective monitoring in the environment. Spiders are gaining importance as ecological indicators due to their extreme sensitivity to natural conditions and disturbances. However, despite their fundamental roles in most natural ecosystems, they have largely been ignored in conservational studies (Pearce and Venier, 2006).

India is one of the mega diversity countries in the world with only 2.4% of the world's land area, harbours 7-8% of all recorded species, counting over 45,000 species of plants and 91,000 species of animals (Pande and Arora, 2014). In India, 1686 species belonging to 438 genera of 60 families of spiders are reported (Keswani et al., 2013). Western Ghats, being one of the global hotspots of biodiversity, supports an enormous vegetal wealth and the entire Western Ghats biogeographic region is a major genetic estate with an enormous biodiversity of ancient lineage. Anthropogenic factors are posing serious threats to the biodiversity of Western Ghats. Land use changes in the Western Ghats over the last century caused by agricultural expansion; conversion to plantations and infrastructural projects have resulted in loss of forests and grasslands (Pius et al., 2015). Studies looking at the effects of forest fragmentation and disturbance have tended to focus on vertebrate groups particularly birds and mammals and plants (Rahman et al., 2011; Korad, 2014; Jhenkhar et al., 2016). There has been a paucity of research on invertebrates in the Western Ghats especially in relation to habitat disturbances and fragmentation (Kapoor, 2008; Mubeen and Basavarajappa, 2018).

Spiders are an important albeit poorly studied group of arthropods that play a major role in the regulation of other invertebrate populations in most ecosystems (Russell-Smith, 1999). Despite their documented ecological role in many ecosystems, high diversity and threats, spiders have received little attention from the conservation community (Sebastian et al., 2005). In the context of conservation planning efforts, preservation of spider diversity requires an understanding of the patterns of diversity on an appropriate regional scale (Uniyal and Shrivastava, 2012). Though spiders form one of the most ubiquitous and diverse group of organisms existing in Kerala, their study remained largely neglected. The present study is an attempt to investigate the spider diversity of selected habitats of Wayanad region of the Western Ghats, Kerala.

MATERIALS AND METHODS

The present study explored the diversity of spiders in different habitats of the Western Ghats, Wayanad region. The investigation was carried out during the period from January 2018 to December 2018.

Study area

Wayanad district is one of the hill stations of Kerala set high on the Western Ghats with altitudes ranging from 700 to 2100m. The 2131km^2 area of Wayanad is rich with agricultural fields, plantations and forest cover. The following habitats were selected for the present study (Figure 1):

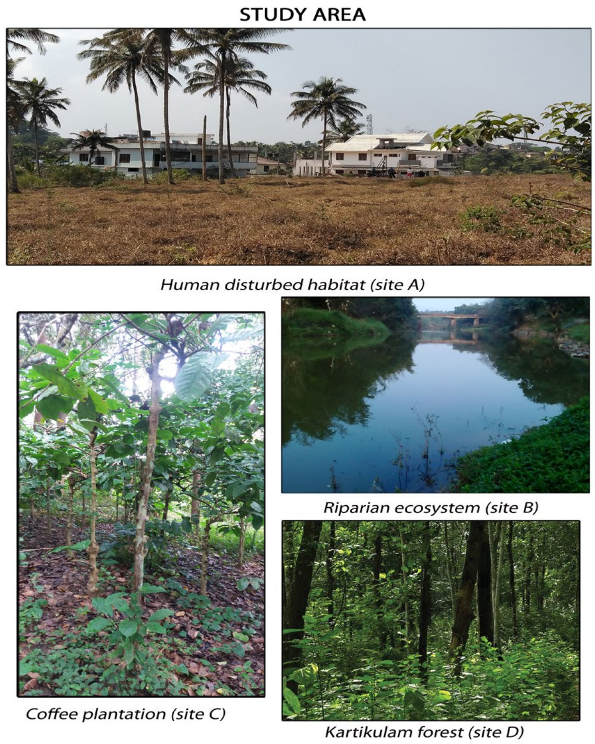

Figure 1: Study sites

1. SITE A – Human disturbed habitat in Mananthavady
Mananthavady municipality is in the Wayanad district which is 3.79% urbanised.

2. SITE B – Riparian ecosystems in Peruvaka
Kabani River, one of the three east flowing rivers of Kerala, is an important tributary of the river Cauvery. Peruvaka is a small countryside along the banks of Kabani. Banana and ginger plantations are maintained in the banks of the stream. Farmers use chemical pesticides, weedicides and fertilizers in their agriculture lands.

3. SITE C – Coffee plantations in Koilery
Koilery, a small village located about 7.9 km away from Mananthavady and is rich in agricultural fields and plantations. Robusta is the most popular variety of coffee being cultivated here. Inorganic fertilizers are being used in this field.

4. SITE D – Undisturbed forests in Kartikulam
Kartikulam Reserve is a forest reserve in the northwest

of Edakod and Chozhapurath Vayal. The forest is rich in flora and fauna. It comes under the Begur forest range, Wayanad, Kerala.

Collection

The spiders were collected during the study period from four different habitats of Wayanad region of the Western Ghats. The following methods were used to collect samples.

Visual Search Method: This method is also called "Hand Collection Method". Spiders were spotted on the flowers, folded leaves, under the leaflets, ground, shrubs, and on the bark. Spiders were easily collected by driving them into a dry container. Collections of most web-building species were made early in the morning. Keen observation is essential for the visual search method.

Inverted Umbrella Method: In this method, an inverted umbrella was placed below flowering plants and shrubs and the branches were shaken thoroughly. Spiders along with insects fell into the inverted umbrella. Spiders were transferred into collecting vials after removing other insects from the umbrella.

Kerchief Method: This method was used for collecting running and wandering spiders, especially those belonging to the families Lycosidae and Salticidae. An open kerchief was thrown over the running spider, which was then carefully caught in the folds of kerchief.

Sweep Net Method: This is one of the simplest methods followed to collect spiders. The ideal habitat for using sweep net was one with grasses and flowers. The habitats were swept as many times as necessary to get a good sample. Spiders that fell into the net were collected before they were escaped.

Small specimens were photographed by using a stereo zoom microscope and large specimens were photographed by using Samsung galaxy J5 (15MP camera).

Preservation

The specimens were preserved in 70% isopropyl alcohol.

Identification

The specimens were identified with the help of experts in spider taxonomy and taxonomic keys of spiders (Tikader, 1987; Murphy and Murphy, 2000; Dippenaar, 2002).

Guild Classification

Ecological characteristics relating to foraging manner, nature of web, prey species, microhabitat use, and daily activity were subjected to guild classification. The spider guild classification was composed according to the families collected during the study. Designation of spider guild was based on the ecological characteristic known for the family (Young and Edwards, 1990; Cardoso et al., 2011).

RESULTS

The present study focused on the spider diversity of four different habitats of the Western Ghats, Wayanad region, Kerala, India. A total of 150 species belonging to 73 genera under 20 families were recorded from the selected habitats. Salticidae was the dominant family constituting 44 species under 19 genera, followed by Araneidae (22 species), Theridiidae (14 species), Thomisidae (9 species), Oxyopidae (9 species), Lycosidae (7 species), Tetragnathidae (7 species), Corrinnidae (5 species), Sparassidae (5 species), Eutichuridae (5 species), Nephilidae (4 species), Uloboridae (4 species), Pisauridae (3 species), Linyphiidae (3 species), Hersiliidae (3 species), Clubionidae (1 species), Ctenidae (1 species), Mimetidae (1 species), Pholcidae (1 species) and Theraphosidae (1 species).

Highest species richness was recorded at Kartikulam reserve (Site D) with 70 species belonging to 14 families. Coffee plantation (Site C) exhibited second highest species richness with 36 species belonging to eight families. Riparian ecosystem (Site B) depicted third highest level of species richness with 28 species belonging to eight families. About 17 species belonging to nine families were recorded from Mananthavady (Site A). So in the present investigation, the highest species richness was observed at Kartikulam reserve as compared to other habitats (Figures 2-11).

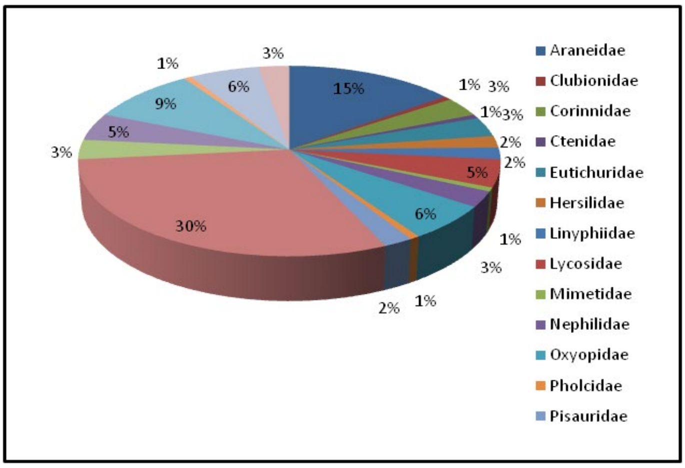

Figure 2: Species distribution in different families found in Western Ghats region, Wayanad

The spiders belonged to seven functional groups based on their foraging mode. Stalkers were the dominant feeding guild with 36%, followed by orb-web builders (24.6%), ambushers (12.6%), space-web builders (10%), ground run

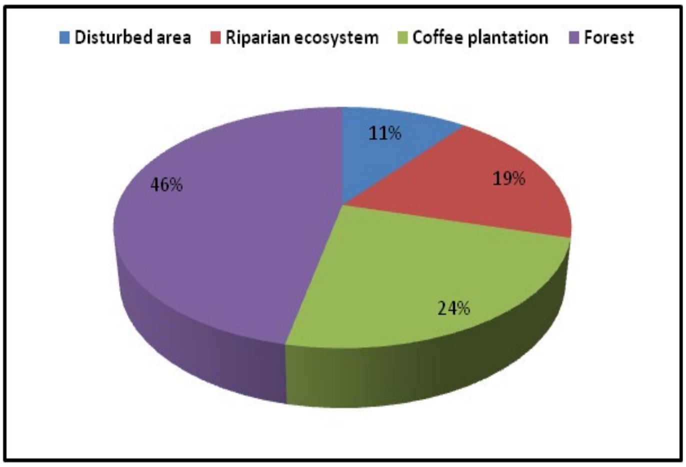

Figure 3: Comparison of spider families recorded from four different habitats of Western Ghats, Wayanad

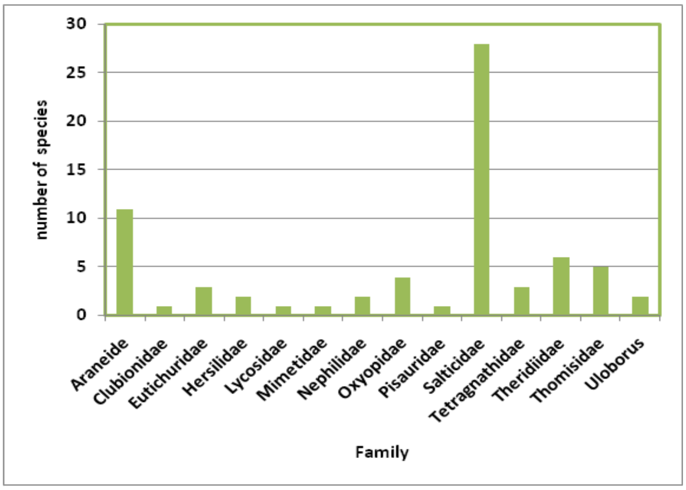

Figure 4: Number of species recorded from site D, Kartikulam forest reserve

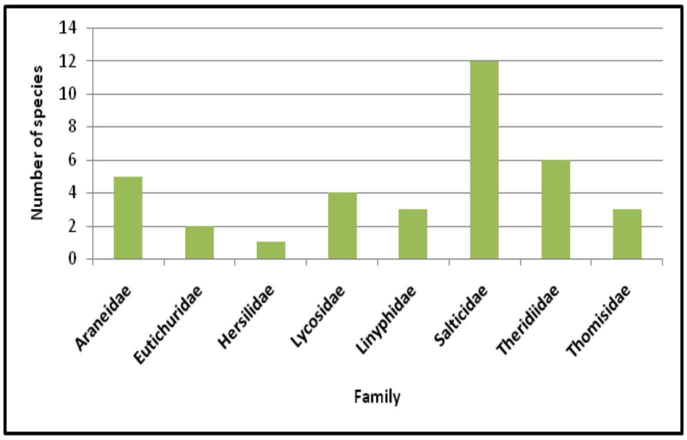

Figure 5: Number of species recorded from site C, coffee plantation, Koilery

ners (8.6%), foliage runners (6%) and sheet-web builders (2%). The dominant guild (Stalkers) was composed of 53 species of the families, Salticidae and Oxyopidae. Orb-web builders constituted 37 species under the families, Araneidae, Tetragnathidae, Uloboridae and Nephilidae (Table 1). In the present study, the habitat preferences of the vari

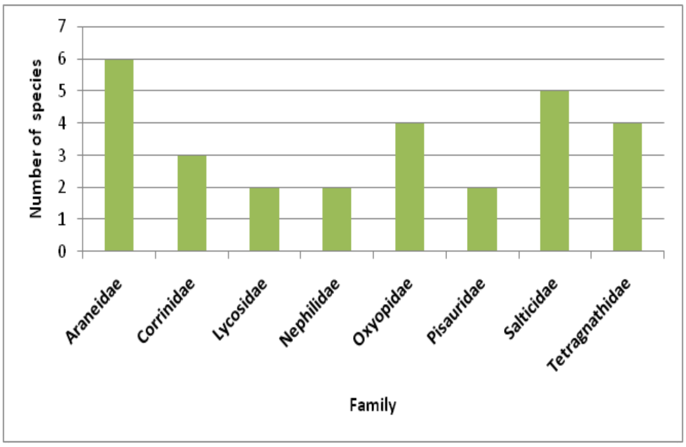

Figure 6: Number of species recorded from site B, riparian ecosystem, Peruvaka

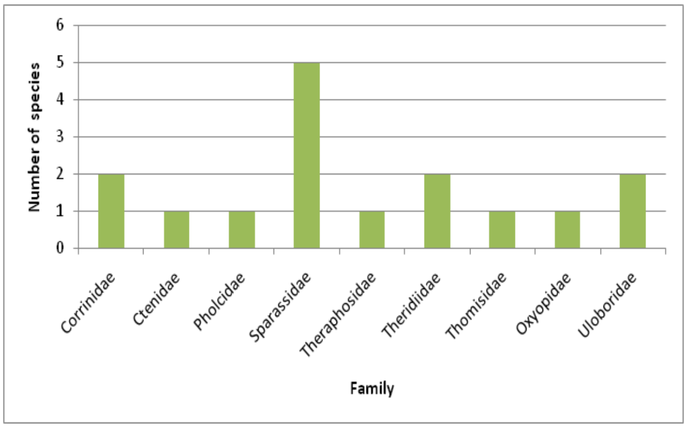

Figure 7: Number of species recorded from site A, disturbed area, Mananthavady

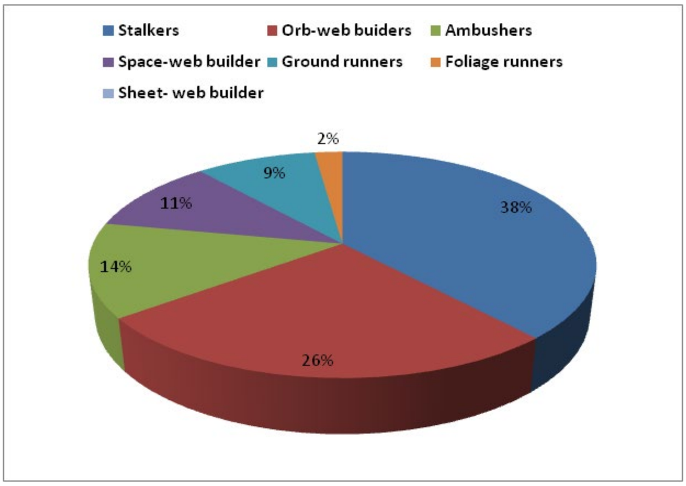

Figure 8: Guild structure analysis of spiders recorded from Western Ghats, Wayanad

ous spider species were also analyzed. Spiders preferred to live in different habitats. Species belonging to Tetragnathidae, Oxyopidae, Theridiidae, Araneidae families were mainly found in vegetation. Tetragnathids are long legged thin bodied spiders found on the webs along the banks of

Figure 9: Species diversity in different families found in Western Ghats, Wayanad

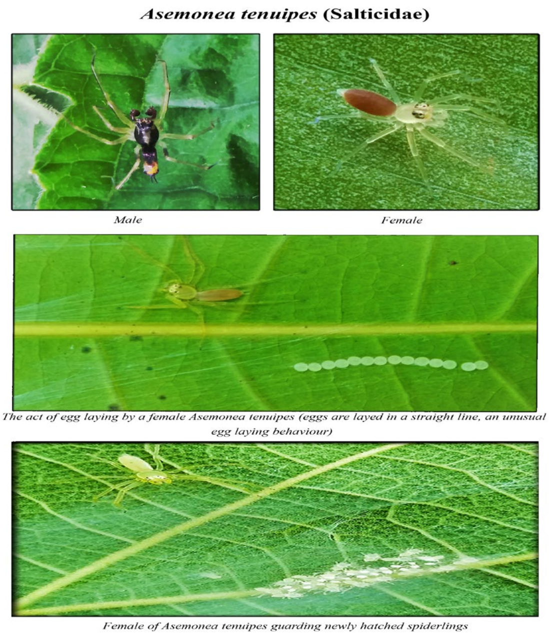

Figure 10: Female of *Asemonea tenuipes* guarding the eggs and newly hatched spiderlings

Female of *Tetragnatha* sp. (Tetragnathidae) guarding the egg-sac and newly hatched spiderlings

Figure 11: Female of *Tetragnatha* (Tetragnathidae) guarding young ones

Table 1: Systematic list of recorded spiders from ecosystems

Family	Species	Guild
Araneidae	*Arachnura angura*	Orb-web builders
	Araneus sp.1	Orb-web builders
	Argiope anasuja	Orb-web builders
	Argiope pulchella	Orb-web builders
	Argiope sp.1	Orb-web builders
	Cyrtophora cicatrosa	Orb-web builders
	Cyrtophora sp.1	Orb-web builders
	Cyrtarachne sp.	Orb-web builders
	Eriovixia excelsa	Orb-web builders
	Eriovixia laglaizei	Orb-web builders
	Eriovixia sp.1	Orb-web builders
	Eriovixia sp.2	Orb-web builders
	Gasteracantha geminata	Orb-web builders
	Neoscona adianta	Orb-web builders
	Neoscona bengalensis	Orb-web builders
	Neoscona crucifera	Orb-web builders
	Neoscona mukerjei	Orb-web builders
	Neoscona vigilans	Orb-web builders
	Neoscona sp.1	Orb-web builders
	Neoscona sp.2	Orb-web builders
	Neoscona sp.3	Orb-web builders
	Parawixia dehaani	Orb-web builders
Clubionidae	*Clubiona* sp.1	Foliage runners
Corinnidae	*Apochinoma* sp.1	Ground runners
	Castianeira zetes	Ground runners
	Castianeira sp.1	Ground runners
	Castianeira sp.2	Ground runners
	Oediognatha sp.1	Ground runners
Ctenidae	*Ctenus cochinensis*	Ground runners
Eutichuridae	*Cheiracanthium melanostomum*	Foliage runners
	Cheiracanthium murrinum	Foliage runners
	Cheiracanthium sp.1	Foliage runners
	Cheiracanthium sp.2	Foliage runners
	Cheiracanthium sp.3	Foliage runners
Hersilidae	*Hersilia striata*	Foliage runners
	Hersilia sp.1	Foliage runners
	Murrica triangularis	Foliage runners
Lycosidae	*Hippasa agelenoides*	Ground runners
	Hippasa sp.1	Ground runners
	Lycosa tista	Ground runners
	Lycosa sp.1	Ground runners
	Lycosa sp.2	Ground runners
	Pardosa mysorensis	Ground runners
	Pardosa sp.1	Ground runners

Lyniphidae	*Lyniphia* sp.1	Sheet-web builder
	Nereine sundaica	Sheet-web builder
	Nereine sp.1	Sheet-web builder
Mimetidae	*Mimetus* sp.1	Ambushers
Nephilidae	*Herennia multipuncta*	Orb-web builders
	Nephila pilipes	Orb-web builders
	Nephila sp.1	Orb-web builders
	Nephila sp.2	Orb-web builders
Oxyopidae	*Hamadruas* sp.1	Stalkers
	Hamataliwa sp.1	Stalkers
	Hamataliwa sp.2	Stalkers
	Hamataliwa sp.3	Stalkers
	Oxyopes javanus	Stalkers
	Oxyopes sunandae	Stalkers
	Oxyopes sp.1	Stalkers
	Oxyopes sp.2	Stalkers
	Oxyopes sp.3	Stalkers
Pholsidae	*Pholcus* sp.1	Space-web builder
Pisauridae	*Dendrolycosa githae*	Ambushers
	Perenthis venusta	Ambushers
	Pisaura sp.	Ambushers
Salticidae	*Asemonea tenuipes*	Stalkers
	Bavia insularis	Stalkers
	Bavia sp.1	Stalkers
	Carrhotus viduus	Stalkers
	Chalcotropis pennata	Stalkers
	Chacotropis sp.1	Stalkers
	Chalcotropis sp.2	Stalkers
	Chrysilla volupe	Stalkers
	Epeus flavobilineatus	Stalkers
	Epeus indicus	Stalkers
	Epeus tener	Stalkers
	Epeus sp.1	Stalkers
	Epeus sp.2	Stalkers
	Epocilla aurantiaca	Stalkers
	Epocilla calcarata	Stalkers
	Hasarius adansoni	Stalkers
	Hyllus semicupreus	Stalkers
	Myrmarachne cornuta	Stalkers
	Myrmarachne japonica	Stalkers
	Myrmarachne maxillosa	Stalkers
	Myrmarachne melanocephala	Stalkers
	Myrmarachne orientales	Stalkers
	Myrmarachne plataleoides	Stalkers
	Myrmarachne prava	Stalkers
	Myrmarachne formicaria	Stalkers
	Myrmarachne sp.1	Stalkers

	Myrmarachne sp.2	Stalkers
	Myrmarachne sp.3	Stalkers
	Myrmarachne sp.4	Stalkers
	Myrmarachne sp.5	Stalkers
	Myrmarachne sp.6	Stalkers
	Plexipus paykuli	Stalkers
	Plexipus petersi	Stalkers
	Rhene danieli	Stalkers
	Rhene flavigera	Stalkers
	Rhene rubrigera	Stalkers
	Siler semiglaucus	Stalkers
	Telamonia dimidiata	Stalkers
	Telamonia elegans	Stalkers
	Thiania bhamoensis	Stalkers
	Menemerus bivittatus	Stalkers
	Phintella vittata	Stalkers
	Piranthus sp.1	Stalkers
	Stenaelurillus sp.1	Stalkers
	Salticid sp.1	Stalkers
Sparassidae	*Heteropoda venatoria*	Ambushers
	Olios sp.1	Ambushers
	Sparassid sp.1	Ambushers
	Sparassid sp.2	Ambushers
	Sparassid sp.3	Ambushers
Tetragnathidae	*Leucauge decorata*	Orb-web builders
	Leucauge tessellata	Orb-web builders
	Tetragnatha mandibulata	Orb-web builders
	Tetragnatha sp.1	Orb-web builders
	Tetragnatha sp.2	Orb-web builders
	Tetragnatha sp.3	Orb-web builder
	Tylorida ventralis	Orb-web builders
Theraphosidae	*Theraphosid* sp.1	Ambushers
Theridiidae	*Argyrode* sp.1	Space-web builder
	Chrysso nigra	Space-web builder
	Chrysso urbasae	Space-web builder
	Chrysso sp.1	Space-web builder
	Meotipa sp.1	Space-web builder
	Meotipa sp.2	Space-web builder
	Theridula gonigaster	Space-web builder
	Theridion manjitar	Space-web builder
	Twaitesia sp.1	Space-web builder
	Coleosoma bluntum	Space-web builder
	Nihonhimea mundula	Space-web builder
	Parasteatoda sp.1	Space-web builder
	Phycosoma sp.1	Space-web builder
	Theridiid sp.	Space-web builder

Thomisidae	*Amyciaea forticeps*	Ambushers
	Amyciaea sp.	Ambushers
	camaricus formosus	Ambushers
	Thomisus lobosus	Ambushers
	Thomisus projectus	Ambushers
	Thomisus telenganensis	Ambushers
	Thomisus sp.	Ambushers
	Thomisus sp.	Ambushers
	Oxytate virens	Ambushers
Uloboridae	*Uloborus khasiensis*	Orb-web builders
	Uloborus krishnae	Orb-web builders
	Uloborus sp.1	Orb-web builders
	Zosis geniculata	Orb-web builders

Table 2: List of ant-mimicking spiders collected

Sl.NO	SPECIES	FAMILY
1	*Apochinoma* sp.	Corinnidae
2	*Castianeira zetes*	Corinnidae
3	*Castianeira* sp.1	Corinnidae
4	*Castianeira* sp.2	Corinnidae
5	*Myrmarachne cornuta*	Salticidae
6	*Myrmarachne japonica*	Salticidae
7	*Myrmarachne maxillosa*	Salticidae
8	*Myrmarachne melanocephala*	Salticidae
9	*Myrmarachne orientales*	Salticidae
10	*Myrmarachne plataleoides*	Salticidae
11	*Myrmarachne prava*	Salticidae
12	*Myrmarachne formicaria*	Salticidae
13	*Myrmarachne* sp.1	Salticidae
14	*Myrmarachne* sp.2	Salticidae
15	*Myrmarachne* sp.3	Salticidae
16	*Myrmarachne* sp.4	Salticidae
17	*Myrmarachne* sp.5	Salticidae
18	*Myrmarachne* sp.6	Salticidae
19	*Amyciacea* forticeps	Thomisidae
20	*Amyciacea* sp.	Thomisidae

rivers. Oxyopids were mainly found on the grasses. Theridiids are usually found at the bottom of leaves. On the other hand, thomisid spiders were found on flowering plants. *Cyrtophora cicatrosa* was found on the three dimensional web on small herbs. *Nephila pilipes* is one of the biggest spiders recorded in the study; it builds a large sized orb-web between adjacent trees. *Arachnura angura* is a scorpion tailed, very rare species found on the leaves and it mimics colourful petals. *Hersilia striata* and *Murrica triangularis* found on the tree barks and they showed clear camouflage. *Hippasa agelenoides* is found in funnel shaped webs and retreats over holes in the ground at the base of the shrubs and active during early morning. Field observations revealed that *Telamonia dimidiata*, *Plexipus petersi, Bavia insularis* ofthe family Salticidae and *Oxyopes sunandae* of the family Oxyopidae were recorded as superior predators of the four ecosystems.

We recorded a rare egg laying behaviour in spiders of the family, Salticidae. Generally, jumping spiders are the group of spiders that constitute the family, Salticidae and they are selective about where they oviposit in nature. *Asemoni atenuipes*, of the family Salticidae, lays eggs in a straight line and it also constructs web in the form of silken platform which is made up of very loose silk threads. The spider also uses the same structures for resting and ovipositing. Interestingly, the present study recorded 20 species of ant-mimicking spiders from different ecosystems. They represented the families such as Corinnidae, Salticidae and Thomisidae. Most of the ant-mimicking spiders were obtained from forest habitat (8 species) and less from riparian ecosystem (7 species) and plantations (5 species) (Table 2) (Figures 9, 10 and 11).

DISCUSSION

Spider diversity, distribution and their insect feeding habits play an important role in the balance of nature (Yong and Edward, 1990). They are potential biological indicators of natural habitats and are used for determining how communities react to environmental changes or disturbances (Marc and Canard, 1997). The status of spider diversity is an important constraint to evaluate the community level of biological organization. Higher species diversity is an indicator of a healthier and complex community because a greater variety of species allows more interactions, hence greater system stability which in turn indicates good environmental conditions (Hill, 1973).

In the current study, a total of 150 species belonging to 73 genera under 20 families were recorded from the selected habitats of Wayanad region. Salticidae was the dominant family constituting 44 species under 19 genera. Highest species richness was recorded at Kartikulam reserve (Site D) with 70 species belonging to 14 families. This habitat showed rich floral (trees and shrubs) and faunal (butterflies, moths, beetles, dragon flies and ants) diversity which is a key factor to build microhabitats for a wide variety of spider species. Coffee plantation (Site C) exhibited second highest species richness with 36 species belonging to eight families. This area also holds a wide range of plants and animals. These varied habitats provide a greater array of microhabitats, microclimatic features, alternative food sources, retreat sites and web attachment sites for spiders. Riparian ecosystem (Site B) depicted third highest level of species richness with 28 species belonging to eight families. The region mainly comprised of banana and ginger plantations and the low species richness may be attributed to the usage of chemical pesticides on the banks of the river. About 17 species belonging to nine families were recorded from Mananthavady (Site A) and vegetation cover was relatively low in this area. So in the present investigation, the highest species richness was observed at Kartikulam reserve (Site D). This may be due to increased vegetation in these areas which lead to the increase in biodiversity and ultimately leads to the greater cover and food resources for these fantastic creatures. Similar results were also reported by other authors in spider diversity studies. Sudhikumar et al. (2005) carried out studies on spider diversity of Mannavan Shola forest and reported 72 species belonging to 57 genera of 20 families. Rendon et al. (2006) studied the spider diversity in coffee plantations of Mexico and recorded 98 species belonging to 56 genera under 20 families. Jose et al. (2018) reported the diversity of spiders in Kavvayi river basin and recorded 112 species belonging to 81 genera and 21 families. The diversity of anthropogenic spiders in the city of Chilpancingo, Guerrero, Mexico was studied by Rodríguez et al. (2015) and recorded 63 species belonging to 49 genera under 21 families. Bonn and Kleinwächter (1999) suggested that species richness increased with habitat divergence and interrelated sets of species traits.

In the present study, seven functional groups were identified based on their foraging mode. Stalkers were the dominant feeding guild with 36%, and followed by orb-web builders (24.66%). Similarly, Sebastian et al. (2005) recorded seven different foraging guilds in the irrigated rice ecosystem of Kerala. Adarsh and Nameer (2013) recorded spider fauna of Kerala Agricultural University, Southern India and the feeding guild structure analysis revealed seven types of functional groups. By contrast, Pandit and Pai (2017) documented the spider fauna from the Taleigao plateau, Goa and they belonged to nine foraging guilds.

Spiders of the families like Tetragnathidae, Oxyopidae, Theridiidae, Araneidae were found mainly on trees, shrubs and herbs in our study. Studies have demonstrated that the spider habitat selection is affected by a variety of biotic and abiotic factors together with the architectural attributes of the habitat. Architectural attributes include size, shape and spatial arrangement of substrate used by spiders (Utez, 1991; Hawksworth and Kalin-Arroyo 1995). Ried and Miller (1989) suggest that structurally more complex habitat types can support a more diverse spider community. In general, spiders have preferences for humidity and temperature and these factors limit them to areas within the range of their physiological tolerances (Pandit and Pai, 2017). The results of the present study and several other observations led to the conclusion that habitat structure and environmental factors may be crucial in determining the composition of spider community of the area. Therefore, documenting spider diversity patterns can provide important information to justify the conservation significance of the ecosystem.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest related to the work.

AUTHORS CONTRIBUTION

Dr Smija M K, Dr Thresiamma Varghese and Dr Prasadan P K contributed to the design and implementation of the research. Ms. Sruthi R collected and contributed the data. Dr Thresiamma Varghese helped to identify the collected specimens. Dr Smija M K contributed to the interpretation of the results. All the authors contributed to the writing of the manuscript.

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