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Spider diversity (Arachnida: Araneae) in selected ten mixed agroecosystems of Palakkad District, Kerala, India

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Abstract

Spiders are successful natural enemies of pests occurring throughout the different strata of an agroecosystem. The study of their functional responses can provide information related to the potential effectiveness of different species and guilds on reducing a pest population. The present paper deals with a study of diversity and distribution of spiders from 10 agro-ecosystems (Pathiripala, Pattambi, Olavakode Railway colony, Kalipara, Mathur, Puliyaparamb, Nallepilly, Mankara, Ezhakkad and Sreekrishnapuram) of Palakkad, District, Kerala, India. The study was conducted for 2 years from July 2021to July 2023. Total 98 species of spiders belonging to 71 genera and 14 families were recorded during the study period. The family Araneidae (26.31%) with 25 species was the most dominant followed by Salticidae (24.21%), Tetragnathidae(12.63 %),Oxyopidae (07.14%). Highest generic diversity was found in the family Salticidae with 22 genera (30.98%) followed by Araneidae (19.71%). Species diversity was maximum in the agro-ecosystems of Sreekrishnapuram (Shannon Index-4.14) followed by Ezhakkad (Shannon Index- 4.08). The less spider diversity was found in the agroecosystems of Mathur (Shannon Index-1.72). The sampled spiders belong to six functional groups (guilds) based on their foraging behavior. The dominant guild was Orb web builders with 38 species (38.77%) followed by Stalkers with 30 species (30.61%). Ground runners and Ambushers (11species each), cob web builders (7species) and Foliage runners (one species) from the study area. Agroecosystem of Pathiripala represents 6 family (50% Araneidae &Diversity index 2.5), Pattambi with 5family (37%Araneidae &Diversity index 2.33), Olavakode Railway colony 6 family (59%Salticidae&Diversity index 2.42),Kalipara 7 family(25 % Araneidae & Diversity index 2.34), Mathur with 4 family (Araneidae and Tetragnathidae 33%&Diversity index 1.72), Puliyaparamb with 7 family (Theridiidae and Araneidae 25% &Diversity index 2.33), Mankara with 7 family (Araneidae and Salticidae (30%) &Diversity index 2.12), Ezhakkad,11 family (28%Araneidae&Diversity index 4.08) and Sreekrishnapuram, 11 family(27% Salticidae & Diversity index 4.14) . Among the families highest shannon diversity index of 3.02 was found in the family Araneidae and 2.9 in salticidae. The structure of the agroecosystem was found to influence the diversity of spiders. Spiders are abundant and wide spread in almost all ecosystems and they are the best indicators of the overall species richness and health of terrestrial communities.

Keywords: Agro-ecosystem, diversity, guild, Araneae, spiders

Introduction

Agricultural landscapes are mosaics of different types of land use, with patches of heterogeneous semi-natural habitats interspersed among cultivated areas. How such a matrix of patches is arranged, which is often highly fragmented (Bennett and Saunders, 2010), is known to strongly influence the composition of the hosted animal communities (Bennett et al. 2006), the biodiversity and provision of ecosystem services (Murcia, 1995). Habitat edges thus become important areas of immigration of animals from natural habitats into adjacent fields. Predators that spillover from natural habitats into crops are able to provide pest regulation services (Tscharntke et al. 2007). The behaviour of predators in both agricultural fields and surrounding habitats is therefore a major research fi eld in the ecology of agricultural landscapes. Spiders are cosmopolitan terrestrial predators and are abundant (Turnbull 1973; Wise 1993), they are also little studied in environments like agroecosystems and nearby lands. Spiders (Araneae) are generalist predators and one very potential biological agent in controlling insect pests in agricultural ecosystems (Marc.et al.1999, Symondson et al. 2002). Spiders contribute immensely to the biodiversity in the agro-ecosystem and play a very important component in natural pest control (Öberg, 2007). Spider community is closely related to the characteristics of the plant community where they live (Foelix, 2010). Suana et al. (2010) stated that the structure of the landscape, habitat type, period of plant growth also play a role in the diversity of the spider species. Family of spiders that are often found in agro-ecosystems and play an important role in the natural control of insect pest species are members of the Araneidae, Lycosidae, Oxyopidae, Salticidae, Tetragnatidae, and Thomisidae (Leticia Bao et al. 2018). Study on spider communities in agroecosystems in Palakkad District is very rarely done. Araneidae was the most dominant family which constitutes 21.5% of the total spider species collected Kavvayi river basin agro-ecosystems. The second dominant family was Salticidae which constitutes 19.5% of total spider population (Jose et al, 2018). Only preliminary Studies on the spider fauna in agro-Ecosystems like Paddy, Banana, Lady's finger and Groundnut of Kozhinjampara Panchayat, Palakkad District was carried out (Ranjini, 2016). An elaborate spider diversity study conducted in the agroecosystems of Western ghats, Wayanad region reports total of 93 species belonging to 71 genera under 19 families. This represents 49% families recorded from the Western Ghats, Kerala. The highest species richness was found in the coffee plantation with 51 species belonging to 11 families. The tea plantation recorded 26 species belonging to 11 families. The rubber plantation showed the lowest species richness with 16 species belonging to ten families (Shabnam et al.2021).

In agroecosystems, a diverse group of spiders may inhabit a wide range of biotopes and they are likely to be active throughout the day (Sunderland, Sanu, 2000). Therefore, assemblages of spider species will leave fewer refuges for potential prey in time and space. Spiders usually exert a strong influence on pest numbers in concert with other natural enemies. In addition to killing the pests by direct attack, spiders cause pest mortality by dislodging them from plants or trapping them in the webs. On the whole, spiders promote the diversity and stability of the natural enemy community and they act as a robust basis of pest control (Sunderland 1999). The present study aimed at estimating species diversity and composition of spiders in ten selected mixed agroecosystems in Palakkad District, Kerala.

Materials and Methods

Study Area

Palakkad district is located between 10 20‟ to 11 14‟N latitude and 76 02‟ to 76 54‟Elongitude. Physiographic divisions of Palakkad district include midland and highland. Withinthese diverse physiographic settings, the total cultivated area in the district occupies 49% of thetotal geographical area. The district has a tropical climate with anoppressive hot season and fairly

assured seasonal rainfall. The temperature of this district ranges between 19 C to 42 C and rainfall differs from 2920mms to 1794mms. Bharathapuzha is the major river flowing in this district. A unique feature of the highland is Palakkad Gap which has its great impact on agro climatic conditions of the region. Much of the areas in the midlands are more or less plain which are very fertile for cultivation. Hence the district is known as the "Granary of Kerala". The major cultivated crops in this district are paddy, coconut, tapioca, fruits, spices, vegetables etc. Majority of the people in this district are engaged in agriculture and its allied sector. Palakkad District is well known for its agriculture. It holds various Ecological units such as lateritic vegetation, agro-ecosystems, seasonal pools, Grasslands etc.

Ten mixed agroecosystems were chosen for the present study

1. SITE A: **Pathiripala**
(10.7795°N,76.4708°E). It is located 23km towards west from District headquarters Palakkad.

2. SITE B : Pattambi
(10.8057°N,76.1957°E) is a taluk at the western end of the Palakkad district of the state of Kerala, India. The flourishing cultivation of paddy, vegetables etc. This is a warm humid region and seasonal variationin the temperature ranges from 21°C to38°C.

3. SITEC: Olavakode Railway colony
(10.7997655185°N, 76.6381039462°E). is a mini town area that is about 5 km from Palakkad town. It is also near the Dhoni hills of Western Ghats. The study area comes under Akathethara Panchayat. Paddy is the main cash crop grown in this area.

4. SITE D: Kalipara municipality (10.8001 N, 76.6804 E) of Palakkad District is well known for its agriculture. Kalipara lies towards south Malabar region of Palakkad and is 4.5km away from Palakkad town.

5. SITE E: Mathur
(10.7479°N, 76.5662°E) is a Village in Kuzhalmannam block in Palakkad, Kerala. It is a vast expanse of verdant plains interspersed with River, stream, forest, paddy fields.

6. SITE F: Puliyaparamb
(10.7765°N, 76.5863°E) is situated in Pirayiri village is situated in Pirayiri village, Palakkad block.

7. SITE G: Nallepilly Panchayath (10.7311°N,76.7841°E) of Palakkad District lies towards eastern region of Palakkad 22km away from Palakkad town. Warm, humid region and the seasonal variation in the temperature ranges from 21 C-39 C.

8. SITE H: Mankara
(10.7918°N,76.4997°E) lies 18km fromthe Palakkad town with a variety of microhabitats including wetlands, paddy fields, woodlands, grasslands, shrubs, forest areas, ponds and rivers etc.

9. SITE I: Ezhakkad
(10.8340°N,76.5806°E) lies west from District headquarters Palakkad and is rich in agricultural fields and plantations. Coconut, rubber, bamboo, banana, fruits, tapioca and vegetables, are the major crop plants cultivated in the observation site.

10. SITE J: Sreekrishnapuram
(10.9067° N, 76.4158° E). The vegetation comprises mostly of rubber plantations, jack, tamarind trees, Coconut , Rice, spices, fruits, tapioca, vegetables groundnut and millets.

Sampling

The current investigation was carried out from July 2021 to July 2023. All surveys were conducted in the morning hours between 7:00 am to 11 am and evening (16.00pm to18.00pm) time to maximize the species richness. Visual searching method was followed for sampling.

Ground search was made under leaf litter and fallen or dry wood. Sweep netting method was followed to collect the foliage dwelling spiders in the herbs and shrubs. Beating was done with a wooden stick and an inverted umbrella was placed under the trees to catch the spiders. Data on web patterns and microhabitat types were recorded with every encounter. The microhabitats types such as ground, litter, foliage, flower, and tree trunk were recorded visually for the presence of spiders. The collected spiders were placed separately in vials with 70% ethyl alcohol. Specimens were observed under a Leica M205 C stereozoom microscope and identified following World Spider Catalog (2020), handbook of Indian spiders (Tikader, 1987), Keralathilechilanthikal (Sudhikumar et al, 2008), taxonomic keys for Indian spiders (SebastianandPeter,2010) The spider guild classification was composed according to the families of spiders collected (Sebastian et al. 2012).

Analysis of Data:

The diversity indices like the Shannon Wiener index (H'), which is sensitive to changes in the abundance of rare species in a community was calculated using the formula.

$$H = -\sum_{j=1}^{S} p_i \ln p_i$$

Where, pi = the observed relative abundance of a particular species in Shannon-Wiener index. Higher the value of H, higher the diversity of species in a particular community. Lower the value of H, lower the diversity. A value of H = 0 indicates a community that only has one species.

Results

A total of 98 species of spiders belonging to 71 genera under 17 families were identified during this study from 10 mixed agroecosystem of Palakkad (Table 1). Family Araneidae (Orb web builder) was found to be the dominant family with 14 genera and 25 species. *Gastracanta geminate* reported from this area under *Araneidae* genus and species found to be new. Other new species reported under *Araneidae* are *Neoscona mukerji, Argiope brought, Anepsion maritatum, Cyclosa bifida, cyrtarachne gravelyi, Parawixia dehaani.* Maximum generic diversity with 22 genera and 23 species was obtained under the family Salticidae. *Stenaellurillus albus, Epeus indicus, Metaeyrba taeniolar* were reported for the first time from Palakkad region comes under family Salticidae. New species reported under family Salticidae *are Rhene rubigera, Telamonia dimidiate, Asemonea tenuipes, Plexippus petersi, Phidippus clarus.* InLycosidae new species found was *Lycosa barnesi. In* Tetragnathidae family14 species under 4 genera were identified. *Opadometa fastigata* was found to be new record. 5 genera and 5 species in Theridiidae (Cob web builder) (Table.1).

The *Araneidae* family in the study records highest number of species diversity with 25 species (26.31%), followed by *Salticidae* with 23 species (24.21%) and *Tetragnathidae* with 12 species *(12.63* %). Highest generic diversity was found in family Salticidae with 22 genera (30.98%) followed by Araneidae (14), Thomisidae (6) Theridiidae (5) and Tetragnathidae (4) (Table.2). Shannon diversity index of family Araneidae - 3.02, Evenness - 0.94, Richness (number of species) - 25 and Total number of individuals found was 906. Shannon diversity index of family Salticidae *was* - 2.9, Evenness -0.924, Richness (number of species) - 23 and Total number of individuals found was 606.

The sampled spiders belong to six functional groups (guilds) based on their foraging behavior (Table.3 &Fig.1). The dominant guild was Orb web builders with 38 species (38.77%) followed by Stalkers with 30 species (30.61%). Ground runners and Ambushers (11species each), cob web builders (7species) and Foliage runners (one species) from the study area (Fig.2).

From the present study highest species diversity recorded under Araneidae (Fig.3) and highest generic diversity under Salticidae (Fig.4). Fig .5 represents diversity and distribution of spider family in site A, Pathiripala. Six family was represented in site A (Araneidae (50%),Salticidae

(15%) Tetragnathidae (14%) and others). Shannon diversity index of the site was 2.5and evenness0.947. Fig.6.represents distribution of spider family from site-B, Pattambi. Dominant family (5) was Araneidae (37%), followed by Tetragnathidae (27%) and Pholcidae (18%). Philodromidae and Salticidae 9% each. Shannon diversity index of site B was 2.33and evenness0.972.Site C, Olavakode Railway colony represents 6 family with dominance of Salticidae (59%) (Fig.7). Shannon diversity index of the site was 2.42 and evenness0.975.

Site D, Kalipara represents 7 family. Here Araneidae dominated with (25%) and Pholcidae, Salticidae and Oxyopidae 17% each Tetragnathidae, Sparassidae and Pisuaridae 8% each (Fig.8). Shannon diversity index of the site was 2.34and evenness0.942.

Site E, Mathur represents only 4 family, the least diverse site. Araneidae and Tetragnathidae 33% each and Philodromidae and Pholcideae 17% each (Fig.9). Shannon diversity index the site was 1.72and evenness 0.96.

Site F, Puliyaparamb Represents 7 family .Theridiidae and Araneidae in equal proportion (25%) followed by Oxyopidae(17%)(Fig.10). Shannon diversity index of the site was 2.33 and evenness 0.938. Site G, Nallepilly (Fig.11) represents 7 family, where Araneidae dominates (42%) and Salticidae and Tetragnathidae (16%) each. Shannon diversity index of the site was 2.91and evenness 0.987.

Site H,Mankara(Fig.12) records only 5 family and equal representation of Araneidae and Salticidae(30%) , followed by Sparassidae (20%).Shannon diversity index of the site was 2.12 and evenness 0.921. Site I: Ezhakkad (Fig.13) represents spiders belonging to 11 family. Highest species diversity recorded under Araneidae (28%) followed by Salticidae (24%) . Shannon diversity index of Ezhakkad site was 4.08 and Evenness 0.862. Site J, Sreekrishnapuram (Fig.14) also represents 11 family out of 17.Salticidae (27%) dominates followed by Araneidae (20%). Shannon diversity index the site was 4.14 and evenness1.06. Among the selected sites diversity index was high in Sreekrishnapuram and low in Mathur.

Table 1: Systematic list of spiders recorded from selected 10 agroecosystems of Palakkad District

Sl.No	Species
Araneidae (Orb web builder)	
1	*Neoscona mukerji*
2	*Argiope pulchella*
3	*Argiope anasuja*
4	*Gastracanta geminata*
5	*Argiope brought*
6	*Araneus mitificus*
7	*Eriovixia laglaizei*
8	*Araneus diadematus*
9	*Nephila pilipes*
10	*Anepsion maritatum*
11	*Argiope keyserlingi*
12	*Cyclosa bifida*
13	*Cyrtarachne gravelyi*
14	*Herennia multipuncta*
15	*Cyrtophora cicatrosa*
16	*Eriovixia excelsa*

17	*Neoscona crucifera*
18	*Phonognatha graeffei*
19	*Neoscona nautica*
20	*Araneus ventricosus*
21	*Parawixia dehaani*
22	*Hypsosinga rubens*
23	*Hypsosinga pygmaea*
24	*Argiope aemula*
25	*Trichonephila inaurata*
Salticidae (Stalkers)	
1	*Stenaellurillus albus*
2	*Hyllus semicupreus*
3	*Rhene rubigera*
4	*Plexippus paykulli*
5	*Telamonia dimidiate*
6	*Phintella vittate*
7	*Chrysilla volupe*
8	*Myrmarachne plataleoides*
9	*Asemonea tenuipes*
10	*Plexippus petersi*
11	*Phintella vittate*
12	*Epeus indicus*
13	*Menemerus bivittatus*
14	*Epocilla aurantiaca*
15	*Stenaelurillus lesserti*
16	*Phidippus clarus*
17	*Hentzia mitrata*
18	*Cosmophasis umbratica*
19	*Phlegra bresnieri*
20	*Hasarius adansoni*
21	*Menemerus semilimbatus*
22	*Metaeyrba taeniola*
23	*Carrhotus viduus*
Lycosidae(Ground runner)	
1	*Pardosa sumatrana*
2	*Pardosa pseudoannulata*
3	*Lycosa barnesi*
Tetragnathidae (Orb web builders)	
1	*Tetragnatha virudorufa*
2	*Tylorida ventralis*
3	*Leucauge fastigata*
4	*Leucage decorata*

5	*Tetragnatha montana*
6	*Tetragnatha elongata*
7	*Opadometa fastigata*
8	*Leucage argyra*
9	*Tetragnatha maxillosa*
10	*Leucage venusta*
11	*Tetragnatha laboriosa*
12	*Tetragnatha sp.*
	Theridiidae (Cob web builder)
1	*Theridion manjithar*
2	*Nihonhimea mundula*
3	*Chrysso spiniventris*
4	*Meotipa sahyadri*
5	*Parasteatoda tepidariorum*
	Thomisidae(Ambusher)
1	*Epidius parvati*
2	*Indoxysticus minutus*
3	*Thomisus spectabilis*
4	*Oxytate virens*
5	*Misumessus oblongus*
6	*Amyciaea forticeps*
	Oxyopidae (Stalkers)
1	*Oxyopes sunandae*
2	*Hamadruas sikkimensis.*
3	*Oxyopes birmanicus*
4	*Oxyopes shweta*
5	*Oxyopes salticus*
6	*Hamadruas hieroglyphica*
7	*Hamadruas insulana*
	Pholcidae(Cob web builder)
1	*Pholcus phalangioides*
2	*Holocnemus pluchei*
	Scytodiidae (Ground runner)
1	*Scytodes thoracica*
2	*Scytodes globula*
	Sparassidae(Ground runner)
1	*Heteropoda venatoria*
2	*Olios mileti*
3	*Heteropoda maxima*
4	*Micrommata virescens*
	Theraphosidae (Ambushers)
1	*Plesiophrictus sp.*
2	*Chilobrachys sp.*

	Cheiracanthiidae (Foliagerunners)
1	*Cheiracanthium*
	Corinnidae (Groundrunners)
1	*Castianeira zetes*
	Pisauridae (Ambushers)
1	*Dolomedes tenebrosus*
2	*Pisaurina dubia*
	Philodromidae (Ambushers)
1	*Tibellus chatursingi*
2	*Philodromus aureolus*
	Gnaphosidae(Groundrunners)
1	*Callilepis nocturna*
	Desidae (Orb-webbuilders)
1	*Badumna insignis*

Table .2. Families, genera, species, and functional guilds of spiders collected from 10 agroecosystems, Palakkad

No	Family	Genera	Species	Guild Structure
1	Araneidae	14	25	Orb web builder
2	Salticidae	22	23	*Stalkers*
3	Tetragnathidae	4	12	Orb web builders
4	Lycosidae	2	3	*Ground runner*
5	Theridiidae	5	5	Cob web builder
6	Thomisidae	6	6	Ambusher
7	Oxyopidae	2	7	Stalkers
8	Pholcidae	2	2	Cob web builder
9	Scytodiidae	2	2	Ground runner
10	Sparassidae	3	4	Ground runner
11	Theraphosidae	2	2	*Ambusher*
12	Cheiracanthiidae	1	1	Foliagerunners
13	Corinnidae	1	1	Groundrunners
14	Pisauridae	1	1	Ambushers
15	Philodromidae	2	2	Ambushers
16	Gnaphosidae	1	1	Groundrunners
17	Desidae	1	1	Orb-webbuilders
	Total	**71**	**98**	

Table.3. Guild structure of spiders from 10 agroecosystem of Palakkad

No	Guild	Percentage	Species
1	Orb web builder	38.77	38
2	*Stalkers*	30.61	30
3	*Ground runner*	11.22	11
4	Cob web builder	7.14	7
5	Ambusher	11.22	11
6	Foliage runner	1.05	1
	Total		**98**

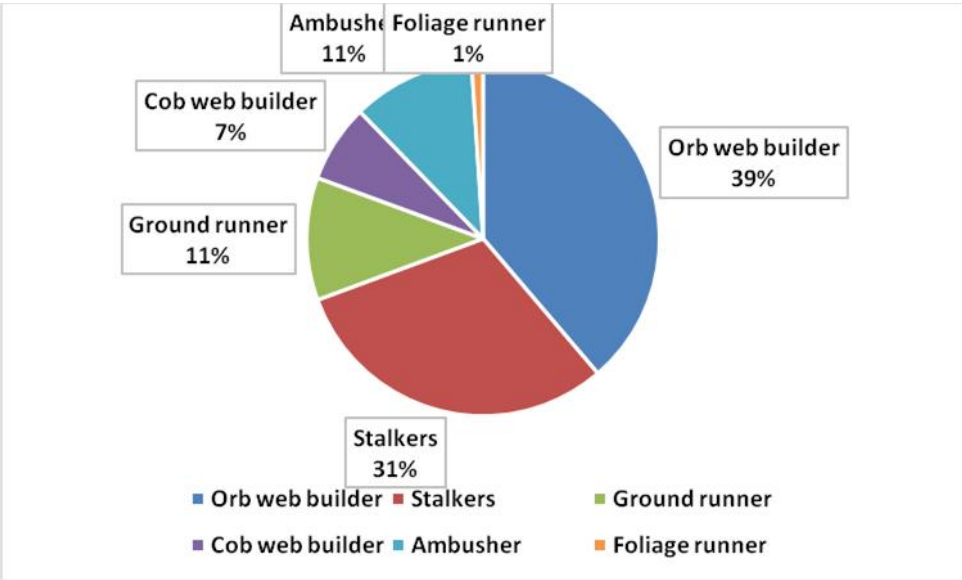


Fig.1. Guild structure analysis of spiders recorded from the study area

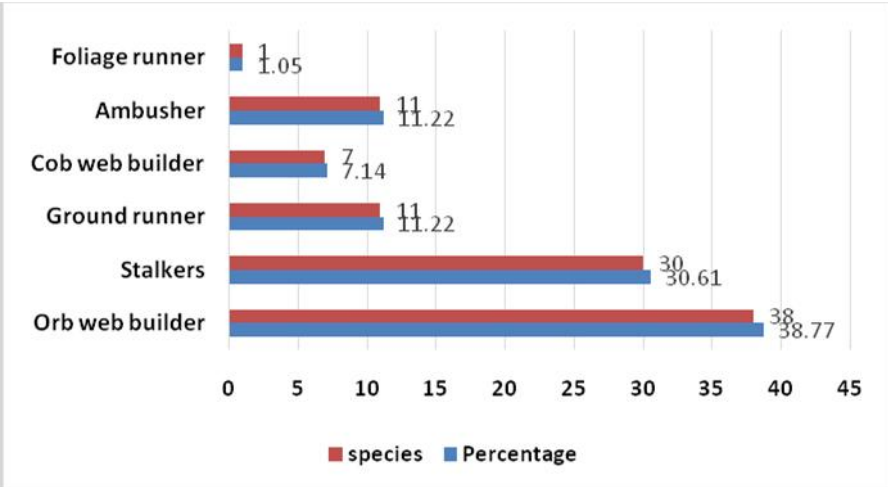


Fig.2. Guild-wise distribution of species of spiders in different Agroecosystems

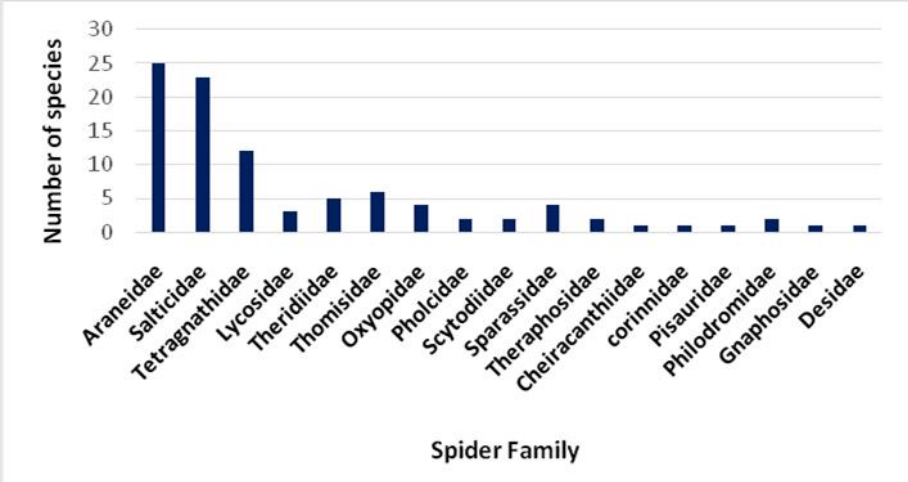


Fig.3. Total species diversity of spiders with respect to family in the study area.

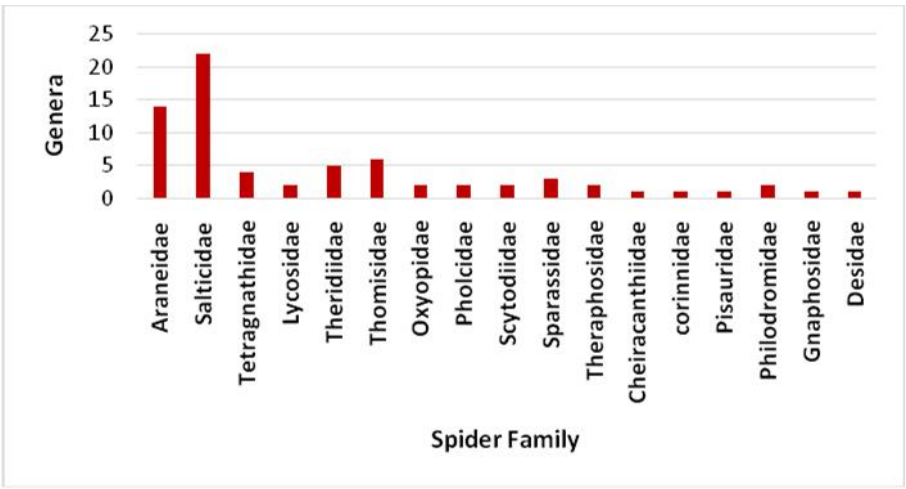


Fig.4. Generic diversity of spiders with respect to family in the study area

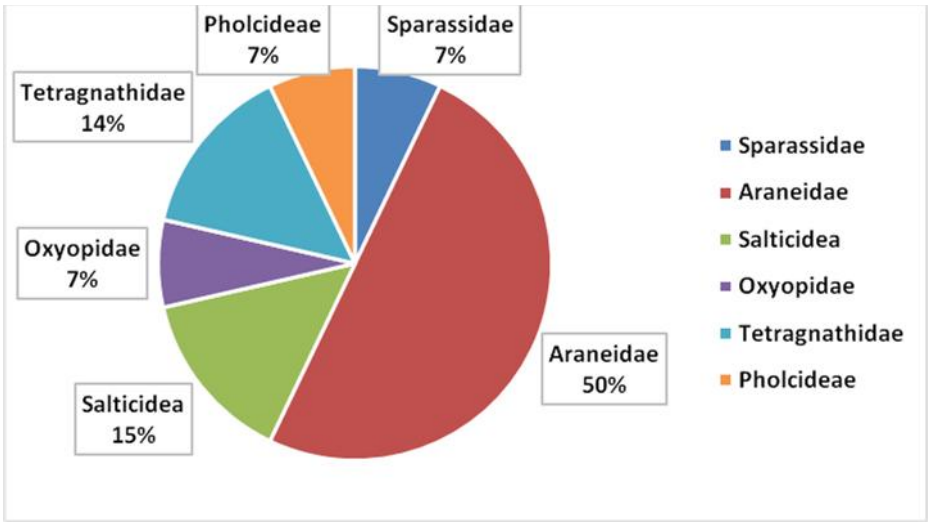


Fig. 5. Spider Diversity of Site A: Pathiripala

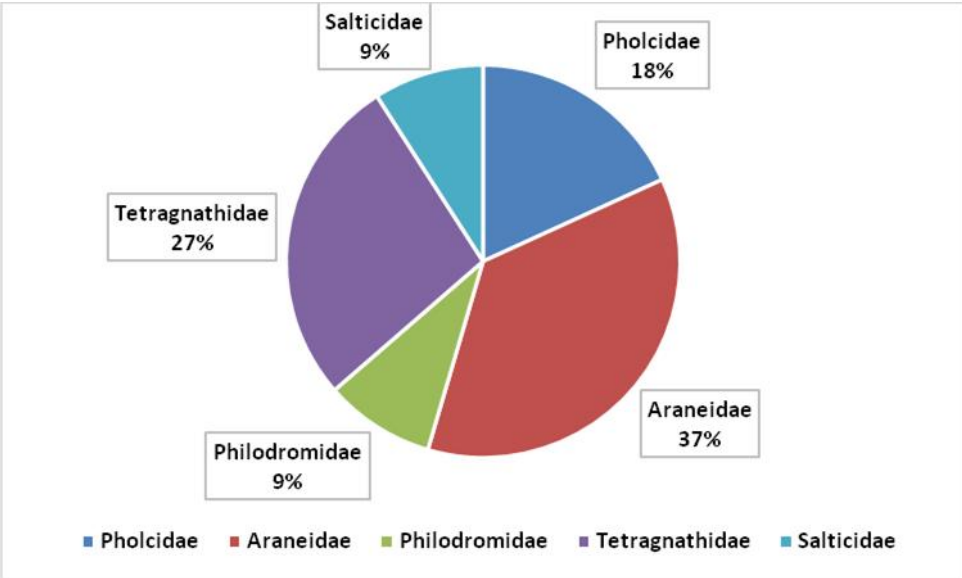


Fig.6. Spider Diversity of Site B :Pattambi

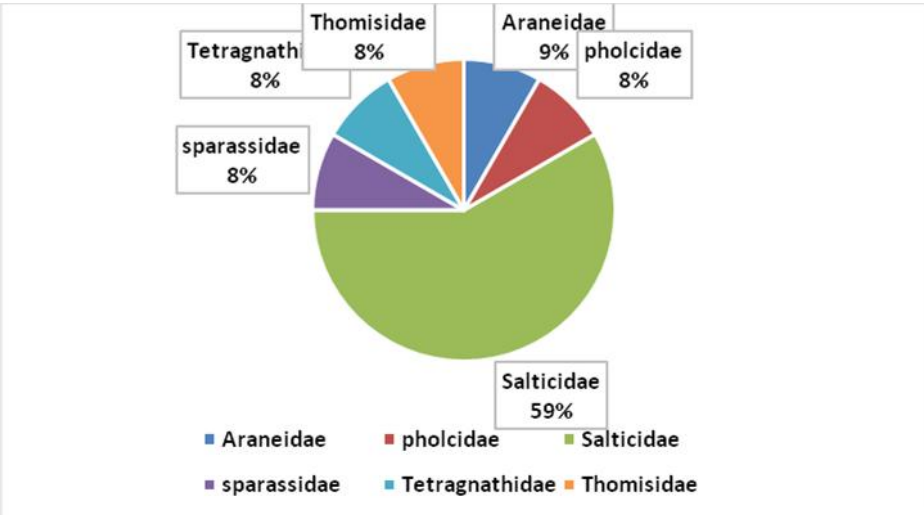


Fig.7. Spider Diversity of Site C :Olavakode Railway colony

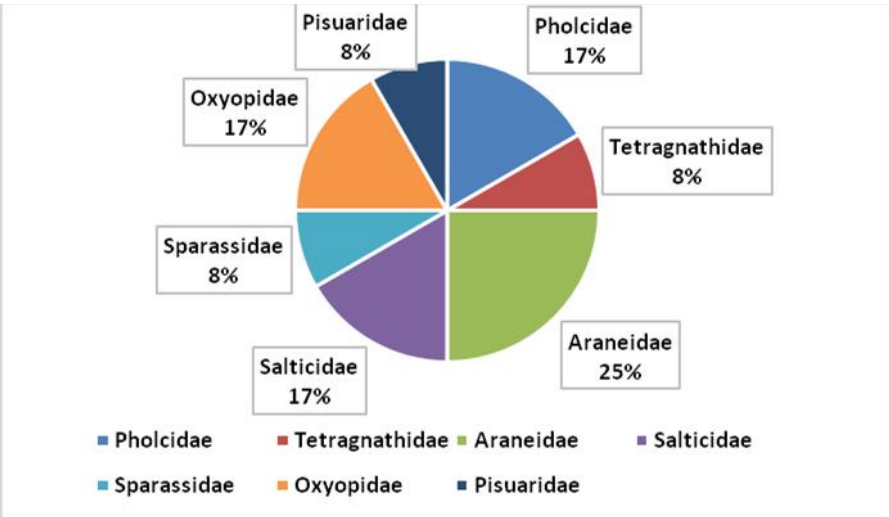


Fig.8. Spider Diversity of Site D: Kalipara

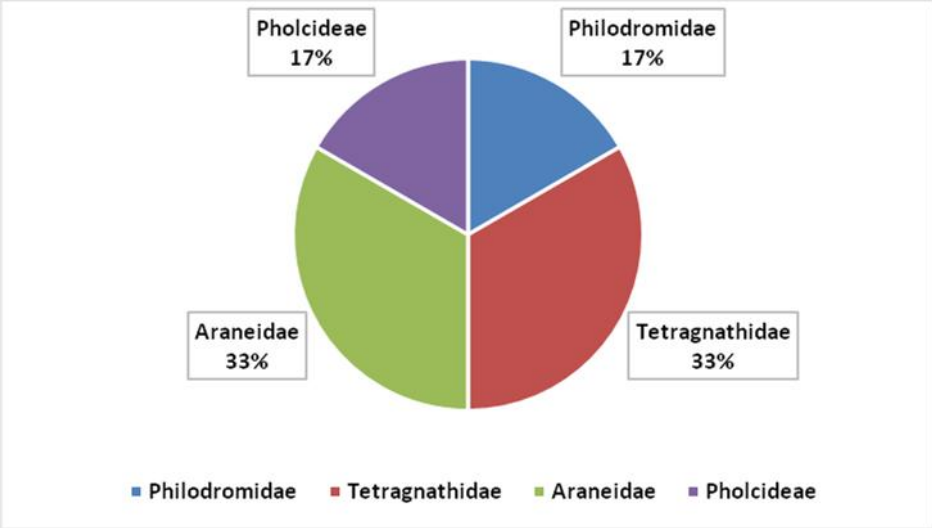


Fig.9. Spider Diversity of Site E: Mathur

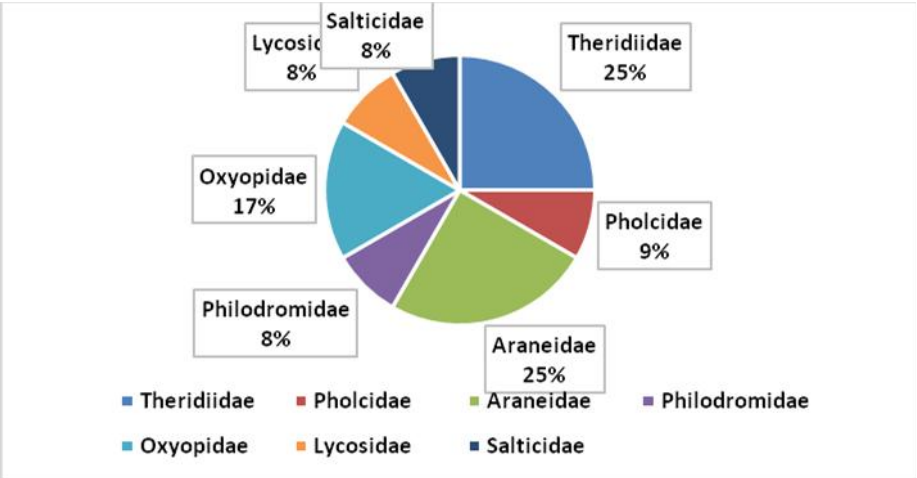


Fig. 10.Spider Diversity of Site F: Puliyaparamb

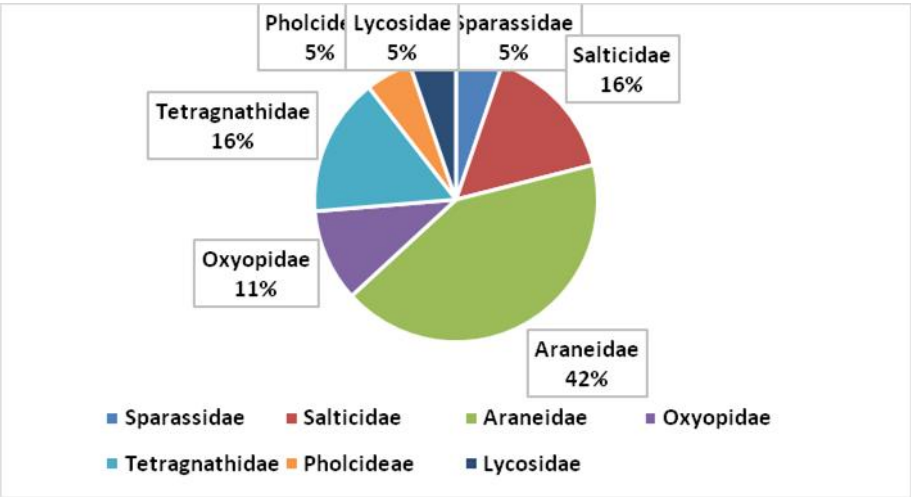


Fig.11. Spider Diversity of Site G: Nallepilly

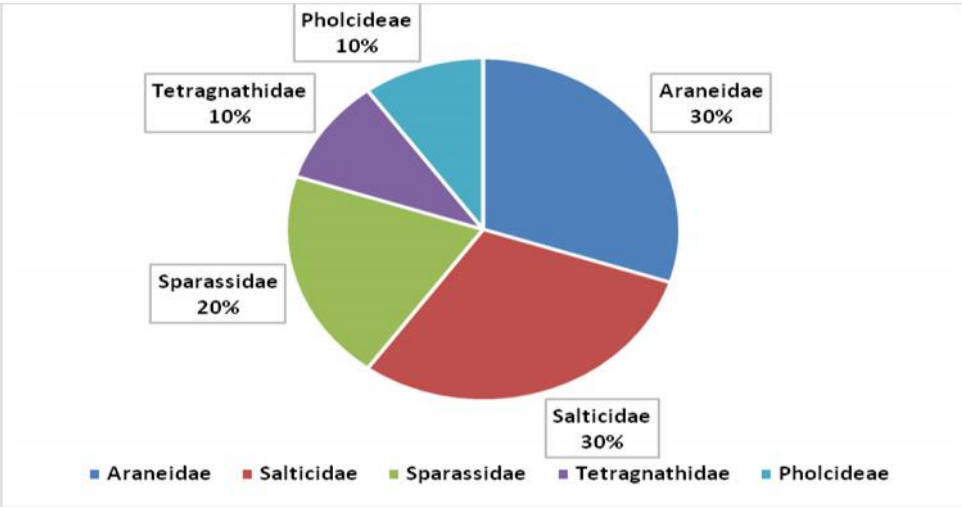


Fig.12. Spider Diversity of Site H : Mankara

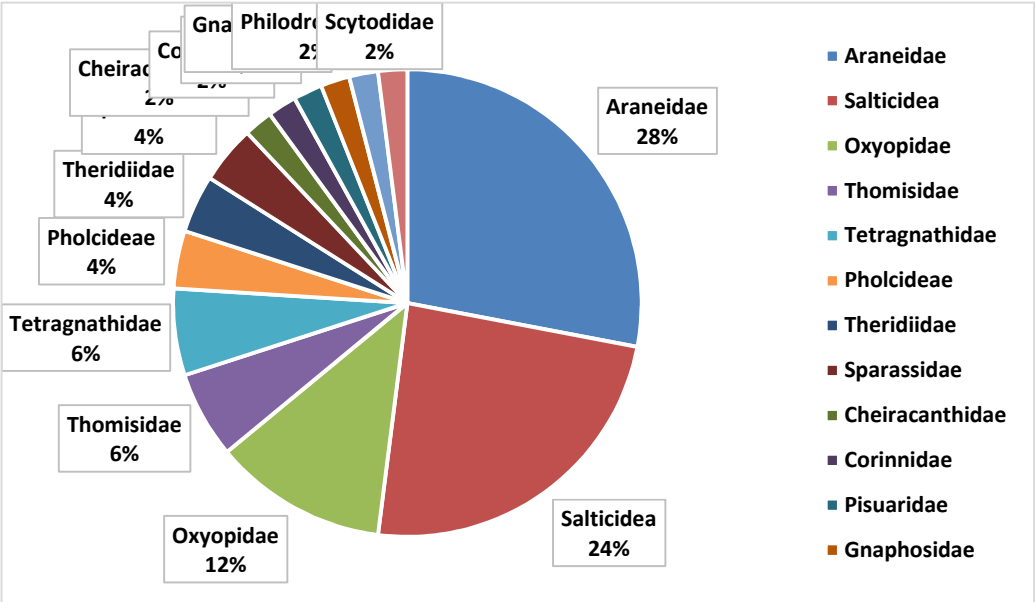


Fig.13. Spider Diversity of Site I: Ezhakkad

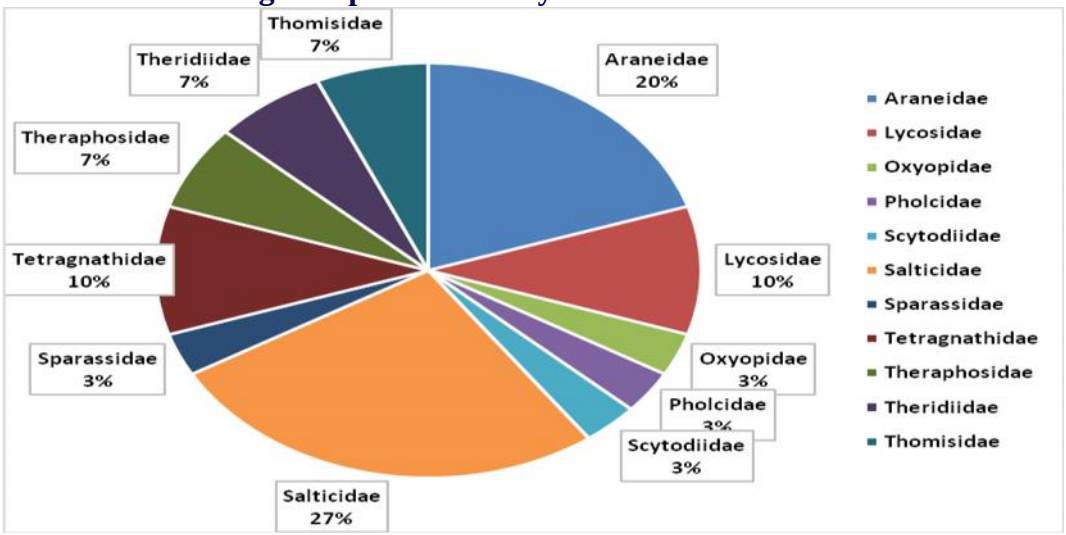


Fig.15. Spider Diversity of Site J: Sreekrishnapuram

FAMILY ARANEIDAE

		
Neoscona mukerji	***Argiope pulchella***	***Argiope anasuja***
		
Gastracanta geminata	***Araneus mitificus***	***Eriovixia laglaizei***
		
Nephila pilipes	***Anepsion maritatum***	***Cyclosa bifida***
		
Herennia multipuncta	***Eriovixia excelsa***	***Parawixia dehaani***

FAMILY SALTICIDAE

		
Plexippus paykulli	***Carrhotus viduus***	***Phidippus clarus***
		
Menemerus bivittatus	***Telamonia dimidiate***	***Epeus indicus***
		
Hyllus semicupreus	***Asemonea tenuipes***	***Phintella vittate***
		
Metaeyrba taeniola	***Chrysilla volupe***	***Rhene rubigera***

FAMILY LYCOSIDAE

		
Pardosa sumatrana	***Pardosa pseudoannulata***	***Lycosa barnesi***

FAMILY TETRAGNATHIDAE

		
Tetragnatha virudorufa	***Tylorida ventralis***	***Leucage decorata***
		
Opadometa fastigata	***Tetragnatha maxillosa***	***Tetragnatha elongata***

FAMILYTHERIDIIDAE

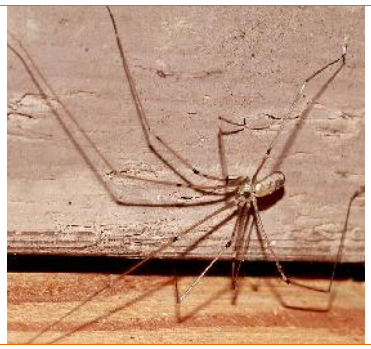
		
Chrysso spiniventris	*Theridion manjithar*	*Meotipa sahyadri*

FAMILY THOMISIDAE

		
Amyciaea forticeps	*Thomisus spectabilis*	*Oxytate virens*

FAMIL YOXYOPIDAE

		
Oxyopes shweta	*Hamadruas hieroglyphica*	*Oxyopes sunandae*

PHOLCIDAE	DESIDAE	SCYTODIIDAE
		
Pholcus phalangioides	*Badumna insignis*	*Scytodes thoracica*
SCYTODIIDAE	**SPARASSIDAE**	**SPARASSIDAE**
		
Scytodes globula	*Olios mileti*	*Heteropoda maxima*
THERAPHOSIDAE	**CHEIRACANTHIIDAE**	**CORINNIDAE**
		
Plesiophrictus sp	*Cheira canthium*	*Castianeira zetes*
PISAURIDAE	**PHILODROMIDAE**	**GNAPHOSIDAE**
		
Dolomedes tenebrosus	*Tibellus chatursingi*	*Callilepis nocturna*

Discussion

Spider diversity in 10 mixed agroecosystems of Palakkad district was studied over a period of two years and recorded 3070 individuals of spiders belonging to 98 species, 71 genera under 17 families. Spiders are potential biological control agents in agroecosystems (Riechert & Lockley 1984, Tanaka 1989, Bishop, Riechert 1990).Spiders are ingenious predators and an integral part of ecosystem, playing an important role in the structure of food webs and communities (Bucher *et al*., 2015; Stokmane & Spungis 2016; Ludwig *et al*., 2018). Biodiversity in agroecosystems responds to local management factors which include crop density, crop diversity, crop rotations, and chemical inputs (Tscharntke *et al*., 2005; Bat´ary, *et al*, 2010). Spiders are generalist predators that can offer important biocontrol services in agriculture (Riechert& Lockley, 1984; Riechert& Bishop, 1990; Riechert& Lawrence, 1997; Symondson, et al, 2002). Spiders prevent and suppress pest outbreaks in arable crops (Riechert & Lockley, 1984; Symondson, *et al*, 2002), and can persist even when pest numbers are low by feeding on alternative prey items within the agroecosystem (Settle *et al*., 1996; Symondson, et al, 2002). Spiders have also an important role in the ecosystem maintenance and are considered as the prospective biological control agents (Riechert and Bishop 1990). Since spiders are crucial for ecosystem organization, knowledge about the diversity of spiders should be systematically applied in order to justify the conservation significance of the ecosystem.

Platnick, (2005) recorded twenty spider families from Kuttanad rice agroecosystem represent 43% of the families reported from the country. The numbers of taxa recorded are generally higher than those reported for other surveys of rice ecosystems. Barrion & Litsinger (1984) collected 13,270 specimens belonging to 51 species under 64 genera and 16 families during a 3-year study from Philippine rice agroecosystem. Jose *et al*. (2018) analysed the diversity of spiders in Kavvayi river basin and recorded 112 species belonging to 81 genera and 21 families. Sruthi *et al*. (2019) documented 150 species belonging to 73 genera under 20 families from different ecosystems of the Western Ghats, Wayanad. Sudhikumar*et al*. (2005) conducted a study on the spider diversity of the Mannavan Shola forest, Munnar and recorded 72 species of 57 genera and 20 families. Spider fauna in cashew orchards of the Cashew Research Station, Madakkathara, reports dominance of Salticidae and Araneidae representing 33 and 27 per cent, respectively, of the total spider fauna. A guild structure analysis revealed six feeding guilds, viz.: stalkers, orb-web builders, foliage runners, scattered line weavers, ground runners, and ambushers (Smitha & Sudhikumar**,** 2020). A rice (*Oryza sativa* L.) field is a complex agroecosystem, containing many aquatic, semi-aquatic, and terrestrial species (Oraze *et al*. 1988). Pathiripala, Pattambi, Olavakode Railway colony, Kalipara, Ehakad and sreekridhnapuram in the study sites have rich stretch of paddy fields together with other agroecosystems. Fathima P Shabnam et al (2021) reported a total of 93 species belonging to 71 genera under 19 families from different agroecosystem of Western Ghats, Kerala. The highest species richness was found in the coffee plantation (site A) with 51 species belonging to 11 families. The tea plantation (site B) recorded 26 species belonging to 11 families. The rubber plantation (site C) showed the lowest species richness with 16 species belonging to ten families. Guild structure analysis of the collected spiders revealed seven functional groups viz.., orb-web builders, stalkers, ambushers, cob-web builders, ground runners, foliage runners and sheet-web builders. In this study also the sampled spiders belong to six functional groups (guilds) based on their foraging behavior. The dominant guild was Orb web builders with 38 species (38.77%) followed by Stalkers with 30 species (30.61%). Ground runners and Ambushers (11species each), cob web builders (7species) and Foliage runners (one species). The vegetation structure of the habitat supports both the web building and non-web building spiders. Additionally, the exclusive presence of more spider species at one site may be related to the existence of a favourable microclimate and adequate web support for these

species. Besides, the site was less exposed to the application of chemical pesticides. When spiders were divided according to their functional group, there was a considerable effect of habitat on the richness of web builders and plant wanderers. In the rice culture ambushers were also more common; however, orbicular web builders had a higher proportion, mainly due to Araneidae and Tetragnathidae (Sebastian *et al*., 2005).

Araneidae family in the current study records highest number of species diversity with 25 species (26.31%), followed by Salticidae with 23 species (24.21%) and Tetragnathidae with 12 species (12.63 %). Highest generic diversity was found in the family Salticidae(30.98%) with 22 genera. Jose *et al*., (2018) reported Araneidae and Salticidae as the dominant families recorded from the basin of the Kavvayi River, Kerala. Rahul Patil *et al*., (2019) reported Araneidae (31.70%) with 13 species was the most dominant family followed by Salticidae (14.63%), Thomisidae (14.63%) from agro-ecosystem like Banana, Sugar- apple, Sorghum and Vineyard of Anjani village, Dist. Sangli.

Araneidae and Salticidae were the dominant families from the garden crops of Western Ghats of India (Poornima 2001). The faunistic survey in the ecosensitive and threatened mangrove forest, Mangalavanam in Kochi yielded 51 species of spiders belonging to 40 genera and 16 families. Araneidae was the most dominant family recording 12 species belonging to 8 genera.Orb weavers and stalkers were the dominant feeding guilds representing 33% and 29% respectively of the total collection (Sebastain et al, 2005). More et al. (2015) demonstrated the dominance of araneid, salticid and lycosid spiders from the Zolambi Region of the Chandoli National Park in the Western Ghats. Sruthi et al. (2019) reported Salticidae as the dominant family from different ecosystems of the Western Ghats, Wayanad Region, Kerala.

Agricultural landscapes are mosaics of different types of land use, with patches of heterogeneous semi-natural habitats interspersed among cultivated areas. How such a matrix of patches is arranged, which is often highly fragmented (Bennett & Saunders, 2010), is known to strongly influence the composition of the hosted animal communities (Bennett et al., 2006), the biodiversity and provision of ecosystem services (Murcia, 1995).

Sreekrishnapuram of the study site represents 11 family with dominance of Salticidae (27%) and diversity index of 4.14 . Thevegetation of Sreekrishnapuram and Ezhakkad comprises rubber, jack, tamarind, Coconut , Rice, banana, spices, fruits, tapioca, vegetables, groundnut and millets, may be the reason for vertical stratification and diversity of spiders. Ezhakkad with 11 family and diversity index of 4.08 with dominance of Araneidae (28%) followed by Salticidae (24%) was obtained. Structurally complex crops providing a wider assortment of resources would be predicted to support a more diverse spider assemblage, thus increasing the chances of the “best” match between spiders and insect pests. Araneidae and Tetragnathidae were mainly foraging at the top layer of the rice plants. This provides sufficient area for the construction of the web and increases the chance of prey entanglement in the webs. The web building and plant wandering spiders rely on vegetation for some part of their lives, either for finding food, building retreats or for web building. The structure of the vegetation is therefore expected to influence the diversity of spiders found in the habitat. There were many more plant wanderers and web builders sampled than ground dwellers. This again indicates that structural diversity of the vegetation may, in some way, influence the spider diversity. Thus, the physical structure of the environments significantly influences the habitat preferences of spider species especially web-building species (Mathew *et al*., 2014).

Kalipara,Puliyaparamb and Nallepilly represents 7 families. Dominance of Araneidae (25%) in Kalipara, 42% in Nallepilly and equal contribution of Araneidae (25%) and Theridiidae (25%) in Puliyaparamb. In OlavakodeSalticidae (59%) and Pathiripala Araneidae (50%) represents 6 families each. Pattambi and Mankara 5 families each. Mathur area under study was the least

diverse site with 4 family where Araneidae and Tetragnathidae(33%) dominates with equal proportion with diversity index of 1.72. Among Paddy, Banana, Lady's finger and Groundnut agro-ecosystems, species diversity and richness was greater in banana agro-ecosystems as per Ranjini (2016) in Kozhinjampara Panchayat, Palakkad District, Kerala.

Uetz (1991) suggests that structurally more complex plants can support more diverse spider community. Vegetation architecture plays a major role in the species composition found within a habitat (Greenstone 1984, Scheidler 1990), and vegetation which is structurally more complex can sustain higher abundance and diversity of spiders (Hatley & Mac Mahon 1980). Spiders play an important role in regulating insect pests in agriculture ecosystems (Nyffeler & Benz, 1987).

Cropping patterns like crop combination, crop diversification and crop concentration of the Palakkad district was attempted by Lekshmi *et al.*, (2018). Comparing the findings of Lekshmi et al (2018) high diversity of crops was seen in Sreekrishnapuram, Ezhakkad and medium crop diversity in the sites of Nalleppilly, Puliyaparamb, Kalipara. Low diversity of crops was found in Mathur, Pattambi, Mankara. In the wetland paddy field spider diversity study at Mudakuzha of Ernakulam 40 species belonging to Aranidae(8) Salticidae (6) was reported by Ambily & Anju Antony (2016). Sudhikumar*et al.,* (2005) studied about seasonal variation of spider abundance in Kuttanadu rice agro systems in Kerala. 54 species from 43 genera and 17 families (Araneids (19.58%), Lycosids (11.29%) and Salticids (10.92%) were recorded from citrus agroecosystem (Seema Keswani,2014). Danisman, *et al.* (2007) investigated spider fauna of cereal fields in Antalya (Araneae). A total of 629 spiders were recorded from wheat, oats and maize fields belonging to 41 species from to 34 genera and 16 families. The abundance and species richness of spiders were higher in woods than in the other habitats. The three-dimensional structures of the edges of perennial woods probably provide a greater availability of alternative food supplies and shelter and suitable microclimate conditions (Herrmann *et a l*., 2010; Pfister *et al*., 2015). The higher density of araneids in adjoining woods and garigue compared to olive groves corresponds well with the increase in araneids within olive groves towards the edges of this habitat (Picchi et al., 2016). The enhancement of spiders in olive orchards for pest control was attempted (Picchi et al., 2020).

Spiders can colonize fields early, feed on alternative prey until pest populations arrive, and target pests before they reach peak densities (Settle *et al.,* 1996; Symondson *et al.*, 2002).

Difference in vegetation architecture different sites chosen and the crop growth accounts for the different community structure of spiders in the present study. In addition, the difference in the seasonal abundance of spiders may be due to the variation in patterns of activity of individual spiders and the phenology of total spider community (Corey *et al*. 1998). Understanding how spiders (Araneae) colonize agro-ecosystems is important since sustaining viable populations of generalist predators is a key attribute of effective integrated pest management.

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