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Diversity of Spider Fauna in the Cotton Field of Thailakulam, Virudhunagar District, Tamil Nadu, India

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Abstract

Biodiversity can be simply defined as the variety of all types of living organism. Spiders are among the most diverge groups on earth, which received the seventh ranking in global diversity after the sixth largest insect orders. Spiders are major playing a vital role in the forest ecosystem is the spiders. In our present study spiders were collected from cotton field area of Thailakulam, Srivilliputtur taluk, Virudhunagar district, Tamil Nadu, India. The spiders were collected from September 2012 to February 2013, using the sweep net, hand ricking, aerial netting, beating method and leaf litter method etc. During this study, 19 species belonging to 18 genera and eight families were collected from cotton field. The scientific knowledge up to species level and taxonomic position and seasonal variation has been studied. The family Salticidae (31.57) harboured highest population followed by three families such as, Araneidae, Lycosidae and Oxyopidae (15.78) and the least number of spiders recorded under the family, Tetragnathidae, Gnaphosidae, Sparassidae and Thomisidae. The richness of the spider species based on the fluctuation in different months may be the seasonal variation and harvesting in the nearby fields in the study area. The population of spiders was abundant species richness and diversity was high during the month of September 2012 to February, 2013. Mean, standard deviation and diversity indices were calculated.

Keywords: Spiders, Cotton, Diversity, Salticidae, Araneidae

1. Introduction

Spiders are widespread and diverse predators that are part of terrestrial Arthropod assemblages [39] and Arthropod comprise more than half of known species. Two distinct types of population structures are present in many spider species, each with different characteristics regarding dynamics and behavior [38]. Spiders belonging to the order Araneae, which is one of the grasping animal group [3]. Spiders are ubiquitous in terrestrial ecosystems and abundant in both natural and agricultural habitats [37]. They play an important role in regulating insect pests in agriculture ecosystems. Spider feed on insect and other Arthropods. They can play important roles in pest's control. 35000 species of spiders have been identified in the world [13, 14]. For instance, some research were performed on spider fauna and abundance of rich field in cotton field (Ghavami *et al*. [14]) sugarcane field, paddy field and terrestrial land. Some spiders dig holes in the ground and make use of shallow holes for hiding. Many spiders prefer dark and shaded location with high humidity [18]. Spiders are one of the most important Arthropods group in agroecosytems. They colonize almost all habitats and have great ability in resisting to adverse ecological conditions. Although spiders are generalist predators, they can be seen as a group of specialised predators, if their different ecological niches are taken into account [22].

Therefore, spiders are extremely important in maintaining pests' densities at low levels, having an important role in pest limitation in agroecosystems [23]. Landscape diversity is an important factor to spider communities. Spiders depend on the surrounding habitat vegetation, shrub and herbaceous layer, since these structures can act as refugee areas [2]. Habitat diversity around the fields enhances migration from the orchard's surroundings, allowing recolonisation of the agroecosystem [3]. Studies on Indian spider Fauna have been carried out by different workers (Biswas and Biswas [4], Patel [26], Gajbe [9]) in different regions of the country and documented 1035 species belonging to 240 genera under 46 families from Indian sub continent. Taking the above points into consideration, the present work is an attempt to document the diversity of spiders in Thailakulam, Srivilliputtur taluk, Virudhunagar district, Tamil Nadu, India, with an aim to explore diversity and seasonal variation on diversity of spiders.

2. Materials and Methods

2.1. Study Area

The study area was located in Thailakulam, Srivilliputtur taluk, Virudhunagar district, Tamil Nadu, India. Srivilliputtur is located at 9.5' longitude and 7.7' altitude. This city is located 156 meter above sea level. Srivilliputtur belongs to Virudhunagar District of Tamil Nadu State of India. This is a warm, humid region and the seasonal variation in the temperature ranges from 30 °C – 38 °C. Humidity is also showing seasonal fluctuation.

2.2. Study Period

The investigation was carried out for a period of six months from September 2012 to February 2013. Sampling was conducted in six months at the randomly selected cotton field.

2.3. Sampling

Sampling was done every month from quadrates. Spiders were collected from 1 quadrates (1sq. m × 1sq. m) placed at four corners and one centre of 10 sq. m × 10 sq. m area by visual search method between 8.00 – 10 hours. A sufficient core area was left to avoid edge effects. All 1 quadrates were searched. Spiders were collected from the ground stratum and from the terminals of plants.

Sampling time was restricted to 20 minutes in each transect, depending on the density of under storey weeds and shrubs to be walked through, and this included time spent on field to identify unfamiliar taxa encountered. The time taken to describe web characteristics (useful in identifying the family, and in some instances, up to the genus level) was excluded from the calculation of sampling time for each transect. Attempts were made to carefully scan the leaf litter surface, tree bark, foliage (Including the under – surface of leaves when traces of webs were found) twigs, and branches of the vegetation (up to 1.5m height) along the transect. Specimens from each quadrate were preserved in 75% alcohol in the field and counted under a microscope in the laboratory.

3. Results

3.1. Taxonomical Characters

The population dynamic of spider collection yielded nineteen species belonging to eighteen genera and eight families. Among the eight sub-families, Salticidae (31.57 %) and Araneidae (15.78 %) and Oxyopidae (15.78 %) represented maximum number of species followed by Lycosidae (15.78 %). The sub-family, Gnaphosidae, Sparrasidae, Tetragnathidae, Thomisidae yielded the least number of species (05.26 % each) (Table 1).

Table 1: Taxonomical diversity of spiders from Thailakulam during September, 2012 –February, 2013

Sub-family	No. of genera	No. of species	% of species
Oxyopidae	3	3	15.78
Tetragnathidae	1	1	5.26
Lycosidae	3	3	15.78
Araneidae	3	3	15.78
Thomisidae	1	1	5.26
Salticidae	5	6	31.57
Gnaphosidae	1	1	5.26
Sparassidae	1	1	5.26
Total	**18**	**19**	

The spiders like, *Peucetia viridana (*Stoliczka), *Oxyopes birmanicus* (Nona Yvette), *Opadometa fastigata* (Simon)*Peucetia latikae* (Tikader), *Lycosa pseudoannulata* (Bosenberg), *Hippasa olivacea* (Thorell), *Neoscona lugubris* (Doleschall), *Phidippus indicus* (Blackwall), *Marpissa thakuriensis* (Tikader), *Thalassius albosinctus* (Doleschall), *Plexippus paykulli* (Audoin), *Plexippus petersi* (Karsch), *Telemonia dimidiatta* (Simon), *Thania phamoniansis* (Tikader), *Olios millet* (pocock), *Argiope anasuja* (Thorell), *Cyrtophora cicastrosa* (Simon), *Gnaphosa poonaensis* (Tikader) *Cyrtophora moluccensis* (Doleschall) were collected and recorded from the cotton field of Thailakulam, Srivilliputtur taluk, Virudhunagar district, Tamil Nadu, India.(Table 2).

Table 2: Mean population of spiders from the cotton field of Thailakulam during September, 2012 –February, 2013.

S. No	Spiders	Family	Sep	Oct	Nov	Dec	Jan	Feb
1	*P. viridana*	Oxyopidae	3.5±1.91	3±1.63	3.2±1.5	1.8±0.95	2.0±0.81	1.2 ±0.95
2	*O. fastigata*	Tetragnathidae	4.5±2.08	4.0±0.81	3.8±0.95	3.5±1	3.2± 0.5	2.8 ± 0.5
3	*O. birmanicus*	Oxyopidae	4.8±2.21	4.0±0.81	4.2±0.5	3.8±0.95	3.2±1.70	3.0 ±1.41
4	*P. latikae*	Oxyopidae	3.2±2.06	3.6±1	3.2±0.5	2.2±0.95	1.8±1.70	1.5±1.41
5	*L. pseudoannulata*	Lycosidae	3.6±0.57	2.8±1.25	2.4±0.57	2.0±1.63	2.0±1.63	1.8±0.95
6	*H. olivacea*	Lycosidae	2.8±0.95	2.0±0.81	1.4±0.57	1.4±0.57	1.2±0.5	1.0±0.81
7	*N. lugubris*	Araneidae	0.8±0.5	0.8±1.5	0.6±0.57	0.3±0.5	0	0
8	*P. indicus*	Salticidae	3.5±0.57	3.2±0.5	3.5±0.57	2.8±0.95	2.2±1.70	2.2±1.70
9	*C. moluccensis*	Thomisidae	3.8±0.95	3.5±0.57	3.5±1	3.5±1.73	3.8±1.70	3.4±1
10	*M. thakuriensis*	Salticidae	1.2±0.95	1.0±1.41	0.8±0.5	1.2±0.5	0.8±0.95	1.0±1.15
11	*T. albosinctus*	Pisauridae	3.0±0.81	2.2±1.5	2.2±1.70	1.2±0.5	1.0±0	0.8±0.95
12	*P. paykulli*	Salticidae	3.8±1.70	3.5±1.29	3.5±1.29	3.5±0.57	3.8±1.70	3.6±1.73
13	*P. petersi*	Salticidae	3.0±1.41	3.5±1.29	3.2±1.25	3.2±1.25	2.8±0.95	3.2±0.5
14	*T. dimidiatta*	Salticidae	2.5±1.73	2.5±0.58	2.5±1.29	2.2±1.89	1.8±0.96	1.5±1.29
15	*T. phamoniansis*	Salticidae	0.5±0.57	0.3±0.95	0.3±0.95	0.5±0.57	0	0
16	*O. milleti*	Sparassidae	0	0	0	0.3±0.95	0	0
17	*A. anasuja*	Araneidae	3.8±1.5	3.8±0.95	4.3±1	3.2±1.25	4.0±0.81	3.5±1.73
18	*C. cicastrosa*	Araneidae	4.8±0.95	4.6±0.85	4.3±1	4.8±0.95	4.6±1.5	4.6±1.25
19	*G. poonaensis*	Gnaphosidae	3.5±1.29	3.5±1.73	3.2±1.25	3.2±1.70	3.5±2.08	3.2±1.92

All the analyzed spiders have hairs throughout the body. The colour of the body is varied from black to white. Moreover combination of body colour was also observed in the study. The number of eyes varied from 6 to 8. Among the web spinners, the webs are higher spherical shape or irregular shape. Spiders considered as biological predators in nature. Many studies have been carried out to evaluate spiders as biological control agents and present an effective method of using spiders to reduction of pest population. Most of the studies were limited to the identification of spiders, and to investigate the dominant spider species, their regional distribution and seasonal fluctuations. Hence, the present investigation is an attempt to study the biodiversity and the relative abundance of spiders in Thailakulam for a period of six months from September 2012 to February 2013.This study clearly indicated that the Salticidae, Oxyopidae and Araneidae fauna of this area is rich and diversified. The major component of the spider population found in this ecosystem was the family Salticidae mainly of *P. petersi* and *P. paykullii*, Araneidae composed mainly of *A. anasuja*, *C. cicastrosa* and Oxyopidae mainly composed of *P. viridana*, *O. birmanicus* and *P. latikae*. The population of *C. cicastrosa* and the Oxyopidae spiders like *P. viridana*, *O. birmanicus* and *P. latikae* *O. fastigata* were higher during September and November and lowered during February. The

Satlicidae spiders, *P. paykullii* and *P. petersi* population was stable throughout the study period. *C. cicastrosa*, *O. birmanicus* and *A. anasuja* were the predominant species of spider followed by *P. indicus*, *G. poonaensis* and *P. latikae* during September. The population of these spiders gradually decreased from September to February. *N. lugubris* and *O. millet* were the least number of spiders. During December, the population of *C. cicastrosa* and *O. birmanicus* were higher. The population of *T. dimidiatta and N. lugubris* were lowered during February. The population of Gnaphosidae spider, *G. poonaensis* and Salticidae spider, *M. thakuriensis*, *C. moluccensis* was stable throughout the study period. *P. paykullii*, *H. olivacea*, *P. viridana*, *T. albosinctus*, *P. latikae* *L. pseudoannulata*, *P. indicus* were higher during September and lowered during February. The population of *O. milleti* was present throughout the study period. Most of the species are lowered from December to February during the study period. *T. phamoniansis* available but during December to February they have less population. The population of *P. viridana* was higher during Septemper to Febrauary (Table 3). *P. viridana*, *O. fastigata*, *P. indicus*, *P.peterisi*, *M. thakuriensis*, *P. paykulli* were the predominant species of spiders in cotton field Thailakulam. These spider populations were higher during the study period.

Table 3: Diversity Indices of spiders from the cotton field of Thailakulam during September, 2012 to February, 2013.

	Sep	Oct	Nov	Dec	Jan	Feb
Taxa_S	18	18	18	19	16	16
Individuals	47	45	43	37	35	32
Dominance_D	0.09236	0.0837	0.09014	0.0986	0.1053	0.1093
Shannon_H	3.147	3.025	3.046	3.121	2.976	2.965
Simpson_1-D	0.9076	0.9163	0.9099	0.9014	0.8947	0.8907
Evenness_e^H/S	1.293	1.144	1.169	1.193	1.226	1.212
Menhinick	2.626	2.683	2.745	3.124	2.704	2.828
Margalef	4.415	4.466	4.52	4.985	4.219	4.328
Equitability_J	1.089	1.046	1.054	1.06	1.073	1.069
Fisher_alpha	10.67	11.12	11.64	15.68	11.4	12.73
Berger-Parker	0.08511	0.08889	0.09302	0.1081	0.1143	0.125

4. Discussion

In the present study, nineteen (19) species of spiders belonging to eight families in Thailakulam collected and identified. These spiders were belonging to the family Salticidae, Oxyopidae, Araneidae, Lycosidae, Thomisidae, Tetragnathidae, Gnaphosidae, and Sparassidae. In this study two species of spiders were observed, one is web weaver and another one is non – web weaver. The web weaving spiders were belonging to the family Araneidae and Lycosidae. The non web weaving spiders were belonging to the family Salticidae, Oxyopidae, Thomisidae, Gnaphosidae, Tetragnathidae and Sparassidae. The reasons for the fluctuation in different months may be due to seasonal variation and harvesting in the nearby fields to search the new niche. The reasons for the fluctuation in different months may be due to drought, flood, natural calamities, and disturbance by other animals, and manmade disturbance. The population dynamics of the individual spider species in different months showed that the population of spider species mainly *O. fastigata*, *P. vridana*, *O. birmanicus*, *P. latikae*, *A. anasuja*, *C. cicatrosa*, *L. pseudoannulata*, *P. petersi* and *P. paykullii* was very high throughout the study period. The increase in the spider density suggests that spider density in influenced by the increase in prey density.

The webbing sites of web builders are easily affected by environmental factors in addition, when the web spaces over lap, there is competition with and between species of web builders. Therefore, hunters probably are more effective predators than web builders. In particular, the interaction of prey and predator shows a constant numerical interaction about these relationships which is fundamental to biological control. Spiders are considered as the favorable biological control agents in the forest eco system. The spiders are abundant throughout and all parts of country. They are an integrated part of all ecosystems and contribute to the balanced ecosystem evidently due to their predatory potential. They are found from hedges, shrubs, bushes and trees. They have also been found in fields of paddy, wheat, rice, sugarcane and other crops etc [28]. Apart from this, spiders are observed in other ecologically different places *viz*., forest floors, under stone and logs, in dead leaves and detritus. The present work includes the taxonomic position, morphological characters, and list of diversified species. The seasonal variation of spider population dynamics from this sites have been observed in the cotton field, maximum web – weaving individual had been found in cotton field November while less number of individual, were recorded during February. The study was resulted to identification of nineteen species belonging to eighteen

genera and eight families. The major families were Salticidae, Araneidae, Oxyopidae and Lycosidae. Spiders are ubiquitous predators that are abundant and diverse in agricultural ecosystems. Spider assemblages have the ability to limit population growth of arthropod pests alone or in combination with other natural enemies (Mansour *et al*. [21], Oraze and Grigarick [25], Riechert and Bishop [3]; Carter and Rypstra [5]). Different studies have shown that spiders' influence on prey populations depends on spider density or biomass. Therefore, relatively high spider abundance has been considered a requirement for pest control in agricultural systems (Greenstone [16]; Riechert, 1999; Sunderland and Samu [34]), but the role of spider diversity in prey regulation is less understood. The same result observed in my study also. Most studies regarding the role of shade tree density and diversity in coffee plantations have found a higher species diversity in more diverse coffee agroecosystems (Perfecto *et al*. [28], Greenberg *et al*. [15]). Perfecto and Snelling [27] found that species diversity of ground-foraging ants decreased with shade reduction whereas coffee-foliage-foraging ant diversity did not change along the same shade gradient. In our study, there was no apparent trend between management and spider diversity. Surprisingly, in five cases, we found an increase in spider diversity as land management increased. These results are contrary to what has previously been reported (Perfecto *et al*. [28], Greenberg *et al*. [15]), and there are several possible explanations. An uncontrolled factor that could affect spider diversity was the presence and density of insectivorous birds, which are known to predate spiders intensely (Gunnarsson [17]). The different predation level could affect spider abundance and composition, by selectively reducing numbers of those spiders species more exposed to bird predation. Another explanation is the possibility that relative diversity levels change between years, as we only made a one-year study, and therefore results should be interpreted with caution. The organic management site had the lowest species richness and diversity, and the highest dominance in the dry season (according to all alpha indices used) with the exception of hunting spiders. In both seasons, web-building spiders were more abundant and had higher species richness than hunting spiders. Among the web-building spiders, *Leucauge argyra* and *Leucauge* sp. were found disproportionately abundant in all sites, but most notably in organic management. The extreme dominance of the *Leucauge* spp. in organic management was the cause for the high values estimated by Simpson index (which is more sensitive to dominant species). The Shannon index values are most affected by species richness and secondarily by evenness. The organic management with low species richness and extreme dominance (reduced evenness) therefore had low Shannon index values. Several authors consider that dominant species tend to exploit resources more efficiently than non-dominant species (Agnew and Smith [1]; Mason *et al*. [24]). Extreme dominance of *Leucauge* spp. in organic management compared to control and conventional management in the dry season may be because the optimum, in shade and humidity conditions, for these species are those of the organic management (intermediate between the control and the conventional sites). *Leucauge mariana* (Keyserling) has been reported as a very abundant species in disturbed habitats in Central America (Eberhard [8], Eberhard and Hube [7]). For these reasons, these species could be more abundant in the coffee systems than in the control site, but the dominance of this species should be subject of a particular study. Spider diversity under the organic management significantly increased in the rainy season due to an increase in species richness and a decrease in the dominant species abundance. In contrast, in conventional management and control, there were no significant differences between the seasons. Theoretically, when populations of competitive dominant species decrease or disappear, species diversity might increase (Putman [29]). In the study period, the population of *O. milleti* and *G. unquifera* were less but present in throughout the study period. These results support the existence of a gradient in species composition, from control site to conventional management, with organic as intermediate, although in the rainy season the difference between organic and conventional management was reduced. This might be explained because in the rainy season the interference of clouds and rain with solar irradiation reduces the differences in temperature and humidity, making the coffee farms more similar in these variables. Additionally, the exclusive presence of a spider species at one site may be related to the existence of a favourable microclimate and/or an adequate web support for these species. For example, *H. olivacea* were high during September and lowered February in Thailakulam. *Spintharus flavidus* (Hentz), had been poorly studied taxonomically and is common under the leaves of bushes (Levi [20]), so it is possible that it could prefer the non disturbed control site, in opposition to the periodically perturbed coffee plantations. On the other hand, *E. brevipes* was found only on control habitat, and is known that the spiders of this family live almost exclusively in wet or humid, shaded forest habitats (Coddington [6]). Some species collected were singletons, as in the case of *Dolichognatha* sp. and *Tetragnatha* sp., and could reflect a demographic rarity. In the summer season, a few species like *P. viridana* and *A. anasuja* of oxyopidae and Araneidae were among the dominant and subdominant species at all sites, showing that they

were not affected by the management gradient. However, with a seasonal change from dry to rainy season, *G. unguifera* became considerably less abundant in all sites. In contrast the population of Salticidae was higher throughout the study period.

5. Conclusion

The study shows information related to the species distribution in a particular habitat with response to environment, disturbance, and availability of food. The spiders such as *P. viridana* and *A. anasuja* were the predominant species of spiders in the study area. The increase in the population of spiders suggests that spider population is influenced by the increase in prey popuilation. In this regard, we conclude that, the spiders like *P. viridana* and *A. anasuja* are the predominant species of biological controlling agents.

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7. References

1. Agnew CW, Smith JW. Ecology of spiders Araneae) in a peanut agroecosystem. *Environ. Entomol*, 1989; 18: 30–42.
2. Alderwireldt M. An ecological analysis of the spider fauna (Araneae) occurring in maize fields, Italian ryegrass fields and their edges zones, by means of different multivariate techniques. *Agriculture, Ecosystems and Environment*. 1989; 27: 293-306.
3. Bishop L, Riechert SE. Spider colonization of agroecosystems: mode and source. *Environmental Entomology*. 1990; 19(6): 1738-1745.
4. Biswas B, Biswas K. Araneae: Spiders, state fauna series 3: Fauna of west Bengal 3. *Zool. Surv. of India, Kolkata*. 1992; 357-500.
5. Carter PE, Rypstra AL, Top-down effects in soybean agro ecosystems: spider density affects herbivore damage. *Oikos*. 1995; 72: 433-439.
6. Coddington JA. The genera of the spider family construction in the spider *Leucauge mariana* directions moved as cues during temporary spiral increasing spider densities in agroecosystems. *Journal of Arachnology*, 1986; 27: 371–377.
7. Eberhard WG, Huber BA. Courtship, copulation, and sperm transfer in *Leucauge mariana* (Araneae, Tetragnathidae) with implications for higher classification. *Journal of Arachnology*. 1998; 26: 342-368.
8. Eberhard WG. Memory of distances and directions moved as cues during temporary spiral construction in the spider *Leucauge mariana* (Araneae: Araneidae). *Journal of Insect Behaviour*. 1988; 1(1):51-66.
9. Gajbe P. Spider of Jabalpur,Madyapradesh (Arachnida: Araneae). *Zoological survey of India, Kolkata*. 2004; 1-154.
10. Gavami S. The role of spiders in Iranian cotton fields. J. Agri. Sci, 2007a; 163: 54.
11. Gavami S, Amin GA, Taghizadeh M, Karimian Z. Investigationof abundance and determination of dominant species of spider species in Iranian cotton fields. *Pak. J. Bio. Sci*. 2008a; 11(2): 181-187.
12. George CS, Murphy WL, Hoover EM, Insects and mites techniques for collection and preservation. *USDA, Miscellaneous Pub*. 1986; P.103.
13. Ghavami S. The role of spiders in citrus orchards in northern part of Iran, Sonbol. *J. Agri. Sci*. 2006b; 150: 33-34.
14. Ghavami S. The role of spiders (Arachinida: Araneae) of Iran. *J. Agri. Sci*. 2007a; 163: 54.
15. Greenberg R, Bichier P, Sterling J. Birdpopulations in rustic and planted shade coffee plantations of eastern Chiapas, Mexico. *Biotropica*. 1997; 29:501–514.
16. Greenstone MH. Spider predation: How and why we study it. *Journal of Arachnology*. 1999; 27: 333-342.
17. Gunnarsson B. Bird predation as a sex- and size-selective agent of the arboreal spider *Pityohyphantes phrygianus*. *Functional Ecology*. 1998; 12(3): 453–458.
18. Humphreys WF. The population dynamics of an Australian wolf spider, Geolycosa godeffroyi (L. Koch 1865) (Araneae: Lycosidae). *J. Anim. Ecol*. 1976; 45: 59-80.
19. Kitching RL, Vickerman G, Laidlaw M, Hurely K. 2000. The comparative assessment of arthropod and tree biodiversityin old world rainforest: The rainforest CRC/ Earthwatch Protocol manual. Cooperative Research centre for Tropical Rainforest Ecology and Management. *Technical Report Rainforest CRC, Cairns.*
20. Levi H. The spider genera Episinus and Spintharus from north America, central America and the west Indies (Araneae: Theridiidae). *Journal New York Entomological Society*. 1954; 62: 65–90.
21. Mansour F, Rosen D, Shulov A, Plaut HN. Evaluation of spiders as biological control agents of *Spodoptera littoralis* larvae on apple in Israel. *Acta Oecologica*. 1980; 1: 225-232.

22. Marc P, Canard A. Maintaining spider biodiversity in agro ecosystems as a tool in pest control. *Agriculture, Ecosystems and* Environment. 1997; 62: 229-235.
23. Marc P, Canard A, Ysnel F. Spiders (Araneae) useful for pest limitation and bioindication. *Agriculture, Ecosystems and Environment*. 1999; 74: 229-273.
24. Mason R, Jennings D, Paul H, Wickman B. Patterns of spider (Araneae) abundance during an outbreak of western spruce budworm (Lepidoptera: Tortricidae).*Environmental Entomology*, 1997; 26: 507–518.
25. Oraze MJ, Grigarick A. Biological control of aster leafhopper (Homoptera: Cicadellidae) and midges (Diptera: Chironomidae) by *Pardosa ramulosa* (Araneae: Lycosidae) in California rice fields. *Journal of Economical Entomology*. 1989; 82: 745–749.
26. Patel BH. A preliminary list of spiders with description of three new species from Parambikulam wildlife sanctuary Kerala. *Zoos. Print .Journal*. 2002; 18(10): 1207-1212.
27. Perfecto I, Snelling R. Biodiversity and the transformation of a tropical agroecosystem: ants in coffee plantations. *Ecological Applications*. 1995; 5: 1084–1097.
28. Perfecto I, Rice RA, Greenberg R, ME Vander Voort. Shade coffee: a disappearing refuge for biodiversity. *Bioscience*. 1996; 46: 598–608.
29. Putman R. Community Ecology. UK. *Chapman and Hall Press. First edition, Universities Press, Hyderabad*. 1994.
30. Riechert SE, Bishop L. Prey control by an assemblage of generalist predators: spiders in garden test systems. *Ecology*. 1990; 71: 1441-1450.
31. Riechert SE, Lockley T. Spider as a biological control agents. *Annu. Rev. Entomol.* 1984; 29: 299-320.
32. Riechert SE. The hows and whys of successful pest suppression by spiders: insights from case studies. *Journal of Arachnology,* 1999; 27: 387-396.
33. Riechert SE. The hows and whys of successful pest suppression by spiders: insights from case studies. *Journal of Arachnology,* 1999; 27: 387-396.
34. Sunderland K, F Samu. Effect of agricultural diversification on the abundance, distribution, and pest control potencial of spider: a review. *Entomologia experimentalia et applicata*, 2000; 95: 1-13.
35. Terborgh J *et al*. Ecological meltdown in predator-free forest fragments. *Science*, 2001; 294: 1923-1926.
36. Tikadar BK. Fauna of India, Spider (Thomisidae). *Journal of Arachnology*, 1980; 1(1): 1-124.
37. Turnbull AL. Ecology of the true spiders (Araneomorphae). *Annu. Rev. Entomol*, 1973; 18: 305-348.
38. Uetz GW, Halaj J, Cady AB, Guild structure of spiders in major crops. *Journal of arachnology*, 1999; 27: 270-280.
39. Wise DH. Spiders in Ecological Webs. Cambridge Univ. Press, 1993; p 328.

Mahalakshmi R. and Jeyaparvathi S. Diversity of Spider Fauna in the Cotton Field of Thailakulam, Virudhunagar District, Tamil Nadu, India. Journal of Zoology Studies. 2014; 1(1): 12-18.

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