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Studies on the Diversity and Density of the Spider in Paddy Field and Non-Cultivated Land at Velankudi Village, Tiruvarur District, Tamil Nadu, India

Selvam Ayyapillai[1]*, Anandhan R.[2] and Karunakaran K.[1]

[1]PG and Research Department of Zoology, T.B.M.L. College, Porayar, Tamil Nadu, India
[2]Government Arts College (Autonomous), Kumbakonam, Tamil Nadu, India

**Corresponding Author*

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Abstract: Biodiversity refers to all the population species and communities in defined area. The spider plays an important role in ecological balance and considered to be the ecological indicators. Spiders are the group of terrestrial predators and complicated by their wide biodiversity strategies. Arthropods are mainly representing the largest number of the biotic diversity in the world. The selected area in Thrivarur Districtis (Tamil Nadu, India) depend on the spider fauna diversity which is more or less natural habitat without much human intervention and rich in floral communities. Spiders are observed and the photograph were taken and recorded. The study was conducted from January 2024 to March 2024. From the study area have nine species of spiders belonging to five families of the order Araneae were recorded in the study fields during the present study period. The composition of spider in both habitats was clearly differed. A total of 136 adult spider belonging to nine species and five families were recorded in paddy field and 78 spiders belonging to seven species and four families were recorded in non-cultivated land. The results of the study indicated the need of the conservation of biodiversity in a selected area.

Keywords: Ecosystem, Spider, Agro-ecosystems, Araneae, Biodiversity

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Introduction

Spiders belonging to the order Araneae, are one of the most predominant group of terrestrial predators. Spiders are amazing as they vary greatly in their size and appearance. While some are brightly coloured, others are very inconspicuous. They are one of the most successful groups of animals with their success based on their venom, which is used to attack and defend. Even though the number of known species of spiders in the world is reported to be about 39,000 (Sebastian and Peter, 2009), their true number in existence may be 1,70,000

(Sebastian and Peter, 2009).

Spiders also have a very diverse range of life styles and foraging behaviors (Turnbull, 1973; Wise, 1993). Based on the foraging strategies spiders are categorized in to many guilds. Basically, spiders are classified into web-building and hunting groups, and are further subdivided into clusters with obvious foraging similarities. The hunting spiders are grouped into foliage runners, ground runners, stalkers and ambushers. The web building spiders are grouped into sheet-web builders, wandering sheet/tangle-weavers, orb-weavers, and 3-D space-web weavers. Their external morphological characters, their protective adaptations and colorations, their habits all present such a range of complexity and variety that they really form engrossing subjects for study.

Spiders were also recorded in the surrounding landscape of agricultural fields, such as a garmented semi-desert habitat nearer to the agroecosystem (Galle and Feher, 2006; Rodrigues *et al*., 2009; Muff *et al*., 2009; Opatovsky *et al*., 2010) in mature forest adjacent to agricultural fields (Hibbert and Budle, 2008), and in the surrounding barren lands to agricultural land (Miliczky and Horton, 2005; Oberg *et al*., 2007; Anjali and Prakash, 2012).

The landscape transformation brought about by the human activity has resulted in the fragmentation of agricultural crop fields. This type of fragmentation carried out due to the lack of irrigation and other reasons. However, the knowledge about the spider population in natural boundaries is still limited in India. Only a small proportion of the barren land literature deals with arthropod although they account for the largest part of the animal biodiversity.

Even though the richness and the abundance of the spiders play vital role as a governing factor for the pest control, the density of the population is more important because, the efficiency of pest control is related to the number of spiders in the field. Spider density variation might not only be temporary but could also vary between different crops. In general, the density is expected to be a function of plant size and complexity (Pekar, 2005). However, the spider composition and density were affected by various form management practices including pesticide sprayed in the fields and its concentration. Before the advent of the "Green Revolution" Indian farmers largely relied on organic manures and cultural methods of pest management, which were helpful in promoting parasitoid and predatory population. However, the continuous use of a wide range of pesticides and inorganic fertilizes to intensify agriculture has caused many side effects, including loss of biodiversity, the problem of secondary pests, insecticide resistance, the resurgence of insect pests, residual toxicity and environmental pollution. The use of biological control agents in the greenhouse environment had been shown to be a viable alternative to pesticide use from both environment and economic perspectives. In this context the spiders are considered to be one of the best friends of farmers as bio-control agents, because they feed on insects which are generally harmful to agriculture.

Keeping in mind the various aspects of the forgoing account on spiders, the present study was carried out in paddy fields (*Oryza sativa*), and non-cultivated land in Velankudi villages in Thiruvarur district of Tamil Nadu, India, from January 2024 to March 2024.

Materials and Methods

Study area

The village Velangudi located in the Nannilam Taluk of Thrivarur District, Tamil Nadu, India was selected for the present study. The present study was carried out in the agricultural land andnon-agricultural land field.

Data were collected from January 2024 to March 2024. Collection and preservation of spiders specimens from both habitats were performed as follows:

Collection of spiders

(i) Spiders resting on the leaf blades and on aerial

webs were collected by using a jar held beneath a web and trapping them using the lid.

(ii) Running and jumping spiders were collected using a wide mouthed transparent plastic jar by placing it in an inverted position where exactly the spider was present. The spider was allowed to crawl to the top and then it was trapped by closing the mouth of the jar with a lid (Patel and Reddy, 1990).

(iii) The underground spiders (funnel web weavers) were collected using a glass test tube. The test tube was inverted to the mouth of the web and the spider was allowed to move it. Then it was gathered and closed (Tikader, 1987).

(iv) Spider resting on walls and tree trunks were collected by hand picking or by directly collecting them into a specimen jar (Patel and Reddy, 1990).

(v) The branches of shrubs were vigorously shaken so that the small spiders that hung with their silky thread were collected directly into the specimen jar.

Preservation of spiders

The collected spiders were transferred to killer jar (entomological) and they were preserved in Odeman's preservative (85 parts 70% ethyl alcohol, 5 parts glycerine and 5 parts glacial acitic acid) with labels containing information regarding date, place of collection and other details.

Identification of Spiders

The spiders were indentified to the species level with the help of keys (Tikader and Malhotra, 1980; Tikader, 1987). For the immature ones identification could be done only up to the family level.

Population of spiders

Extensive surveys were carried out to document various species and numbers of spiders in the both habitats described earlier. The surveys were carried out in an area of 33 cent (1335 m^2) at each crop field viz., Paddy and Barren land. Ten random plots (1x1 m) were selected in different locations of each field. The locations of the quadrates were different in each day of observation throughout the study period in order to minimize the disturbance with farm managements and also there should not be a deterrent attraction for the other animals. Two hours were spent for each day on each habitat with a interval of one week. The observations were made during morning hours (between 6 am to 8 am) since it was observed that spider activity was maximum at that time. The area around each plant was searched for possible webs and the plants were thoroughly examined from the bottom to the top for spiders. At the time of observations the populations of different species of spiders were estimated by direct count method (Sebastian *et al*., 2005).

The individual and spider family densities in both habitats were calculated as number /cent. The diversity of spiders in both habitats were analyzed by widely used indices like the Shannon – Wiener index (H1) (Shannon-Wiener, 1949) as follow:

$$H1 = E1 \log P1$$

Where, P1 = the observed relative abundance (proportion) of a particular species.

Statistical Analysis

Basic statistics viz., arithmetic mean, standard deviation and standard error were calculated for all the replicate variable and are given as x +ISD or X + ISE. Statistical analysis were performed by using windows based statistical packages, viz. Microsoft Excel and SPSS (Statistical Package for Social Science; Nie *et al*., 1975). Mainly parametric tests viz., One way ANOVA, 't" test were used to test the hypothesis that of the month, resulted in different abundance and composition of spider assemblages. For hypothesis testing $p<0.05$, $p<0.01$ and $p<0.001$ were considered and these levels of significance were indicated at appropriate places. Statistical inferences were made by following Sokal and Rahlf (1995) and Zar (2003).

Table 1: Occurrence and abundance of Spider species in Paddy Field and adjacent Barren Land during the Study Period

S. No.	Family	Name of the spider	Cultivated Land	Non-Cultivated land
1.	Araneidae	*Araneus inustus*	8	7
		Argiope anasuja	0	10
2.	Tetragnathidae	*Tetragnatha javana*	12	5
		Tetragnatha cochinensis	14	7
		Tetragnatha mandibulata	6	8
3.	Oxyopidae	*Oxyopes javanus*	42	22
4.	Lycosidae	*Pardosa pseudoannulata*	36	13
		Pardosa sumatrana	13	6
5.	Clubionidae	*Clubiona drassodes*	5	0
			136	78

Results

Diversity of Spider

Nine species of spiders belonging to five families of the order Araneae were recorded in the study fields during the study period (Table 1). The composition of spider in both habitats was clearly differed. A total of 136 adult spiders belonging to nine species and five families were recorded in paddy field and 78 spiders belonging to seven species and four families were recorded in non-cultivated land (Table 1). The overall population of spider species was higher in paddy field than non-cultivated land (t-test=3.34, P<0.002; Fig. 1).

Shannon-Wiener diversity measures (H1) for spider species, family and guild in both habitats are given in Table 2. The paddy field had higher species diversity and family diversity and the barren land had a higher diversity of spider guild.

Abundance of Spider

Among the nine species observed only seven species were commonly found in both habitats studied. The species of *P. pseudoannulata* was the predominant species (Fig. 2). Overall population percentage of spider family in both habitats is shown in Figure 2. Maximum number of spiders was observed in paddy field (Fig. 3) and minimum number of spiders was observed in non-cultivated land (Fig. 4). More percentage of orb-web builders were found in paddy field and highest percentage of cone-web builders were recorded in non-

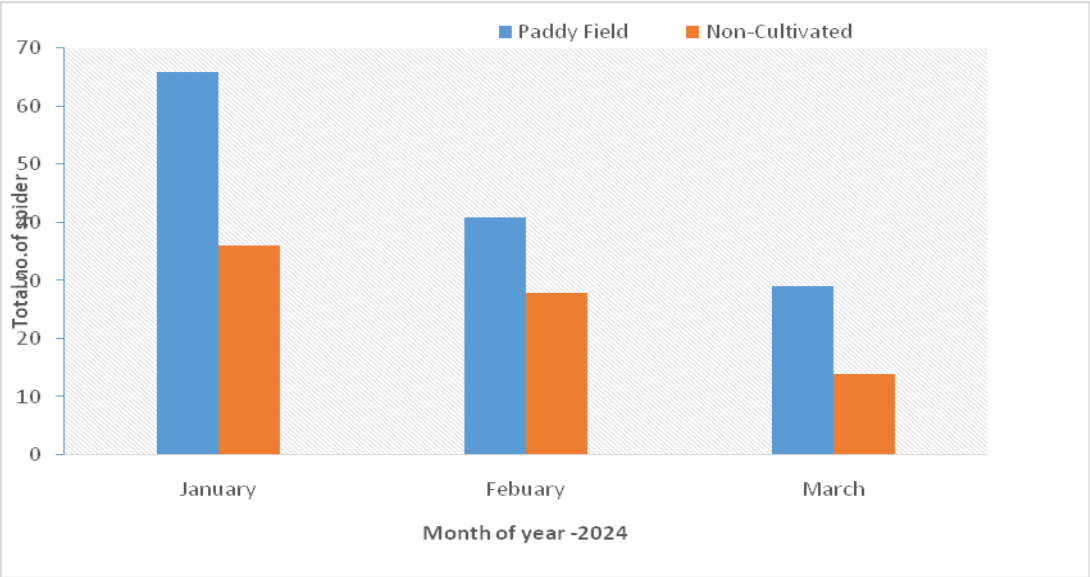

Fig.1: Total number of spiders recorded in paddy field and non-cultivated land during study period. Maximum number of spiders was recorded in January 2024.

Table 2: Habitat wise difference of density of spider in different month during study period

S. No.	Habitat type	Total Sample Size	Month		
			January 2021 Mean±SD	February 2021 Mean±SD	March 2021 Mean±SD
1.	Paddy field	30	6.6±1.95(10)	4.1±2.6(10)	2.9±2.02(10)
2.	Non-cultivated Land	30	3.6±1.43(10)	2.8±1.87 (10)	1.4±1.17(10)

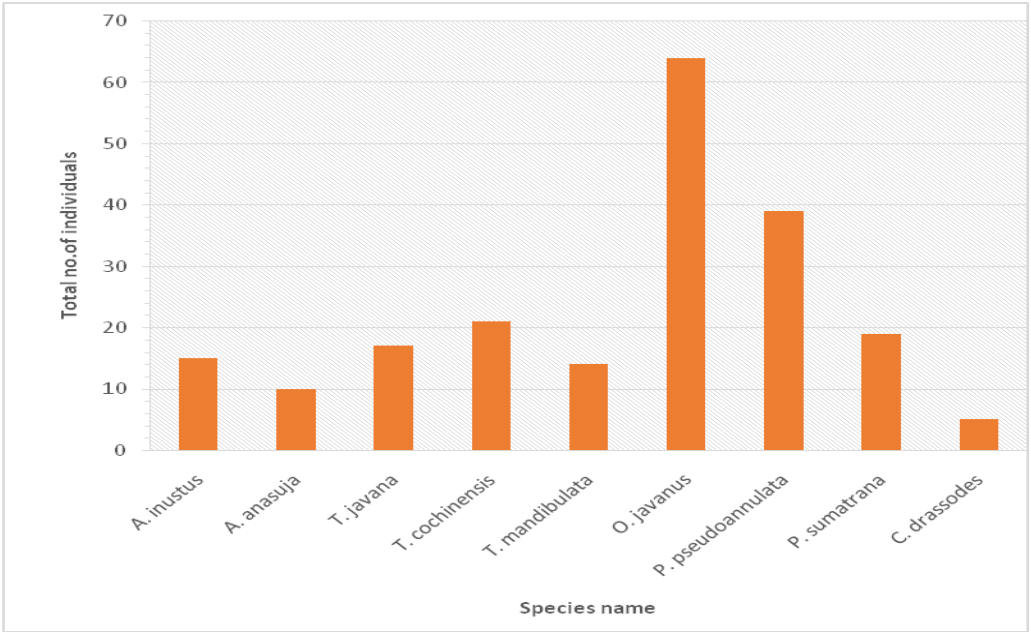

Fig. 2: Total number of spiders recorded at both habitats during study period.

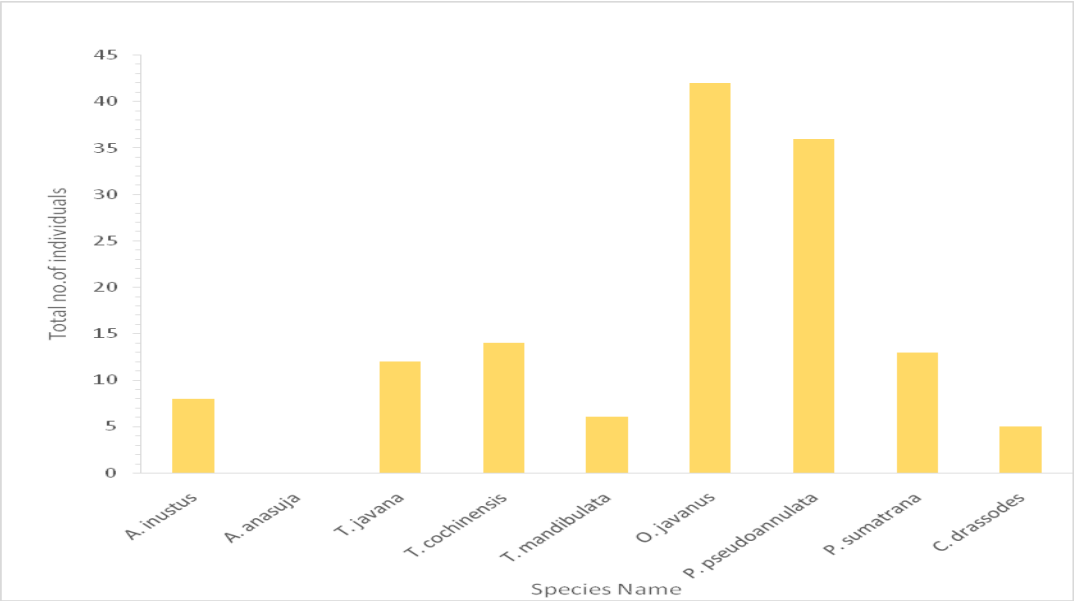

Fig. 3: Total number of spiders recorded at Paddy Field.

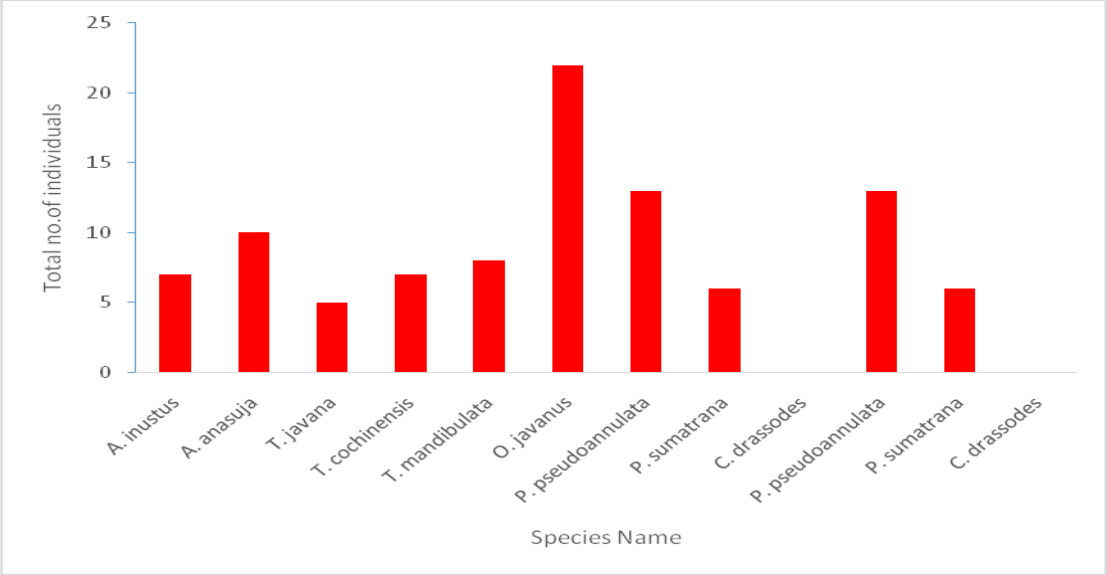

Fig. 4: Total number of spiders recorded at non- cultivated land.

cultivated land. Overall population percentage of spider guilds in both habitats is shown in Figure 5.

Population of Spiders in Paddy field

Variations in the densities of spiders during different months

Variations in the densities (no./m2) of different spider species during different month of the study period in the paddy fields of the present tudy area are given in Table 3. The spider *P. pseudoannulata, P. sumatrana, H. agelinoides, T. javana* and *T. cochinensis* were recorded in all the months of the study in the paddy fields. A catenulate was recorded only from the month of July and their peak was in August. Likewise *P. pseudoannulata* and *H. agelinoides* were more in

Table 3: Total number of individuals was recorded in each quadrate and different month at paddy field

Sampling No.	Jan-24	Feb-24	Mar-24
1	4	3	3
2	8	2	2
3	5	4	0
4	8	9	1
5	4	5	4
6	6	2	5
7	10	6	5
8	7	2	6
9	8	1	2
10	6	7	1
Mean±SD (10)	6.6±1.95	4.1±2.6	2.9±2.02
One-way ANOVA	F=7.28, P<0.00		

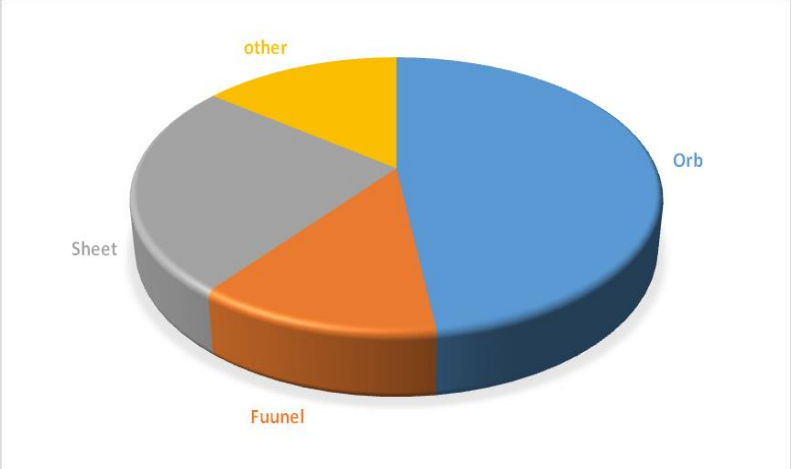

Fig. 5:Percentage of spider web was record at study period.

January. The species *T. albocinctus* was the lowest densities recorded in the field. The densities of all the selected spider species varied monthly in the paddy fields of the present study area (ANOVA; $p<0.01$).

Variations in the densities (no./m2) of different spider family during different month of the study period in the paddy fields of the present study area are given in Table 2. The Lycosidae and Tetragnathidae were recorded throughout the study period and the Lycosidae was more in the month of January and February. The densities of all spider families significantly varied among the month studied in the study area (ANOVA; $p<0.05$). Variations in the densities (no./m2) of different spider guilds during different month of the study

Table 4: Total number of individuals was recorded in each quadrate and different month at non-cultivated land

Sampling No.	Jan-24	Feb-24	Mar-24
1	3	4	2
2	4	3	3
3	5	2	0
4	6	3	1
5	4	1	2
6	3	1	2
7	2	4	0
8	4	2	3
9	1	1	1
10	4	7	0
Mean±SD (10)	3.6±1.43(10)	2.8±1.87 (10)	1.4±1.17(10)
One-way ANOVA	F=5.37, P<0.01		

period in the paddy fields of the present study area are given in Table 3.

Population of Spiders in Non-cultivated land

Variations in the densities of spiders during different months

Variations in the densities (no./m2) of different spider species during different months of the study period in the barren land of the present study area are given in Table 1. The spider *P. pseudoannulata*, *P. sumatrana*, *H. agelinoides*, *T. javana, O. javanus, O birmanicus* and *O. lineatipies* were recorded in all the months of the study in the non-cultivated land. *P. sumatrana* was recorded more in the month of March. Out of eight species of spiders, six species were recorded in all the months studied while *A. catenulate, A. inustus, T. cochinensis* and *T. mandibulata* were not recorded throughout the study period. The densities of all the selected spider species except *P. pseudoannulata* varied monthly in the non-cultivated land of the present study area..

Variations in the densities (no./m2) of different spider families during different months of the study period in the non-cultivated land of the present study area are given Table 4. All the spider families were recorded throughout the study period and their variation in densities were statistically significant (ANOVA; $p<0.01$). All the spider guilds were recorded throughout the study period and the highest density of orb-web was observed. All the spider guilds had a significant variation among the months (ANOVA; $p<0.01$).

Discussion

Nine Species of spiders belonging to five families were recorded in the study fields. A total of 136 adult spider belonging to six species and four families were recorded in paddy field and 78 spiders belonging to eight species and four families were recorded in non-cultivated land. The spider communities of the both habitats differed clearly in their species composition. This is in agreement with the similar findings in many studies at different part of world (Muff *et al*., 2009). Based on the type of habitat, the habitat that has the most abundance, richness, diversity and evenness of species of spider is primary

forest. The presence of spiders in an ecosystem is strongly influenced by environ-mental factors such as temperature, humidity, wind and intensity of light. The high abundance and diversity of species in primary forest is due to its complex structure and relatively undisturbed state, allowing for the creation of niches that can sustain more individual spiders. Biological factors such as vegetation type, food availability, competitors and enemies are all factors that limit the presence of spiders only or of other animals as well in an ecosystem.

The physical structure of the habitat such as leaves, twigs and other plant parts where spiders may spin their webs is also important. Spinning webs is an early stage of selection of spider habitat. The diversity of species generally will increase in line with the increasing diversity of habitat structure. The high value of the primary forest species evenness showed dominance of the species found in primary forests lower than agricultural land and secondary forests. Evenness value of species will tend to be lower when the samples contain one or several dominant species while most other species have very small amounts.

More percentage of orb-web was found in paddy field as compared with non-cultivated land. This observation was similar with that of Rodrigues *et al*. (2009). They have recorded more in rice fields in southern Brazil. The present study also indicated that cone web was found higher at non-cultivated land. In comparison the paddy field has higher orb- web. Further studies are required for more details in species-wise habitat selection of spider in different habitat.

Conclusion

Arthropods are mainly representing the largest number of the biotic diversity in the world. Among them spiders are playing a very important role in the ecosystem. The high abundance and diversity of microhabitats allows their effect in the environment. They serve as important connection between trophic levels and several are important indicators of changing the environment. Spiders are occupied by a considerable portion of animal life of the diversity of group. Therefore, in this investigation on terrestrial spider diversity in selected area of Tiruvarur District, one with rich vegetation and another with less vegetation area, proved that faunal diversity depends to the flora diversity.

Ethical Statement

All ethical guidelines have been followed provided by PG and Research Department of Zoology, T.B.M.L. College, Porayar, Tamil Nadu, India.

Author Contributions

Anandan and *Selvam Ayyapillai* framed the study idea, *Selvam Ayyapillai* and *Karunakaran* edited manuscript and wrote the paper. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest

The authors declare no conflicts of interest.

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