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Diversity and abundance of Spider population (Arachnida: Araneae) in some selected localities in and around Madurai city, India

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ABSTRACT

A study of spider species diversity was conducted in some selected localities of in and around Madurai city from October 2019 to March 2020. A total of 29 species of spiders belonging to 22 genera from 6 families were identified from the study sites. Araneidae and Salticidae were found to be the most dominant family with species from 6 and 7 genera respectively. Based on guild structure analysis, Orb-web builders and stalkers were the most dominant feeding guilds. There were considerable disparities in spider species diversity and distribution across all study sites during the study period, with Vadipatti (23 species) having the highest spider species diversity and Kelavasal (7 species) having the lowest diversity. Spider species diversity (Shannon's index), richness (Margalef's index) and evenness (Pielou's index) indices were higher on Vattipatti (2.23; 3.37; 0.46), and least in the Kelavasal (1.11; 1.06; 0.23). Among 29 species, *Argiope anasuja*, *Cyrtophara cicatrosa*, *Cyrtophora citricola*, *Gasteracantha geminata* and *Myrmarachne bengalensi*s were the most dominant species in Vatipatti and Arasakulam due to the existence of their prey and diverse range of plants, which influenced that these species were more dominant. The present study revealed that spider diversity was higher in rural areas (Vatipatti and Arasakulam) with superior ecological settings, but lower in urban areas (Thiagarajar College campus and Kelavasal) with the most intact ecological environment.

Key words *: Madurai city, Urban habitat, Spider diversity, Species richness, Shannon's index.*

Introduction

The spider is one of the most important organisms in all ecosystems, because they are predatory, and they maintain ecological balance in agroecosystems, and they are also considered as indicators of the health of an ecosystem, since they are sensitive to habitat loss, climatic change, environmental disruptions etc. (Mathew *et al*., 2005; Oyeniyi and Oyewole, 2014). Currently, the world spider list contains 46,879 species under 4062 genera divided among 114 families. There are 1447 species and 15 subspecies of spiders found in India (Pandit *et al*., 2017). The spider has been classified into two suborders, Mesotelae and Opisthothelae, which is made up of infraorders such as Mygalomorphae and Araneomorphae (Sewlal, 2006; Oyeniyi and Oyewole, 2014). It has long been recognized by several entomologists that spiders are one of the most important predators for controlling pests of different crops (Nyffeler, 1999;

Mashavakure *et al*., 2019). As reported by Keswani and Vankhede (2014), spiders are helpful to farmers as they control different types of pests on different food crops.

Human impacts have resulted in significant changes in the composition and variety of the majority of known ecosystems, particularly in spider and other faunas (Tack *et al*., 1993; Barnes *et al*., 2001). Because there have been inadequate research comparing sampling methodologies and faunal species in Indian tropical regions (Gadagkar *et al*., 1990), information on spider diversity and assemblages in and around Madurai is scarce. In order to address all of these concerns, this study will look into the community structure, diversity, and richness of spider species in selected localities in and around Madurai city. Accurate documentation of spider diversity patterns would be tremendously valuable for insect pest management in Madurai agriculture farmers.

Materials and Methods

Study area

A spider diversity survey was conducted around Madurai on some selected sites (9.93°N, 78.12°E). Madurai is the world's oldest continuously inhabited city, dating back more than 2500 years. Additionally, Madurai is home to several famous hindu historical temples, including Meenakshi Amman, Tirupparankunram Murugan, Alagar Kovil, Koodal Azhagar temple, and Pazhamudircholai Murugan temple. The city is altitude at a height of 101 metres or 330 feet above sea level. The annual rainfall averages around 840 mm. The average annual temperature is 28.8 °C. Seasonal variations in humidity can be seen.

The study sites were divided into two categories:

(1) Rural habitats: with less human disturbance (i.e., agricultural fields in Vadipatti and Arasakulam villages) and
(2) Urban habitats: with higher human disturbance (i.e., educational institute and Residential areas in Thiagarajar College and Kilavasal respectively).

Data Collection and Analysis

The study was conducted for six months from October 2019 to March 2020. Spider diversity and abundance data were gathered for four hours every day, from 7:00 a.m. to 11:00 a.m., for four days per month. During the study period, 64 hours were spent collecting data in each of the selected areas. Data on the number of spider species that were physically observed in each study area were collected using an All-out-search method (Gadagkar *et al*., 1993). The effort involved in data collecting was kept consistent to the greatest possible.

To the maximum extent possible, specimen collection was avoided. The majority of the documentation was done by photography, and the abundance of spiders was classified as Common (C), Rare (R), and Abundant (A). The spider diversity data was entered into Excel® spreadsheets to aid in the analysis of ecological indices. Species diversity (Shannon's and Simpson's), richness (Menhinick's and Margalef's), and evenness (Pielous) indices were calculated using PAST statistical software (Hammer *et al*., 2001).

Results

During the six-month study period, a total of 29 spiders from six families and 22 genera were recorded. 16 (55.17 percent) of the total (29) species found were rare, 8 (27.58 percent) species were common, and 5 (17.24 percent) species were abundant. Nine species were found in the Araneidae family (31.03 percent), eight in the Salticidae family (27.60 percent), five in the Tetragnathidae family (17.24 percent), three in the Sparassidae family (10.34 percent), two in the Oxyopidae family (6.90%), and one each in the Pholcidae family (3.45%) and Hersiliidae family (3.45%). Araneidae is the most abundant family, with nine species. Based on their foraging mode, the spiders were divided into five functional categories: the most popular feeding guild was Orb-web builders, with 48.27 percent, followed by Stalkers (27.58%), Ambushers (10.34%), Foliage runner (10.34%), and Irregular-web builders (3.44%) (Table 1).

According to data collected from study sites, a total of 29 spider species were observed in 4 distinct areas: 23 species in Vadipatti, 17 species in Arasakulam, 11 species in Thiagarajar College campus, and 7 species in Kelavasal. Among the 29 taxa, three species, *Argiope anasuja*, *Cyrtophara cicatrosa*, and *Pholcus phalangioides*, were found in practically all of the study sites. The most abundant spider spe-

Table 1. An Observation of Spider species diversity and distribution in selected localities in and around Madurai from October 2019 to March 2020

S. No.	Family / Species	No. of Individuals observed				FO	IUCN Status	Guild
		Rural Habitats		Urban Habitats				
		Vattipatti	Arasakulam	Thiagarajar College Campus	Kelavasal			
1. FAMILY: ARANEIDAE								
1	*Araneus dimidiatus*	10	6	AB	AB	R	NE	OWB
2	*Araneus mitificus*	3	AB	AB	AB	R	LC	OWB
3	*Argiope anasuja*	60	55	187	28	A	NE	OWB
4	*Cyrtophora cicatrosa*	39	122	8	20	A	NE	OWB
5	*Cyrtophora citricola*	59	82	AB	26	A	NE	OWB
6	*Gasteracantha geminata*	16	119	9	AB	C	NE	OWB
7	*Neoscona theisi*	7	4	AB	AB	R	LC	OWB
8	*Neoscona nautical*	AB	1	2	AB	R	NE	OWB
9	*Zygiella atrica*	3	AB	6	9	C	LC	OWB
2. FAMILY: OXYOPIDAE								
10	*Oxyopes shweta*	3	4	AB	AB	C	LC	FR
11	*Peucetia viridians*	4	6	AB	AB	C	NE	FR
3. FAMILY: SALTICIDAE								
12	*Hyllus semicupreus*	33	AB	AB	AB	R	NE	S
13	*Menemerus bivittatus*	AB	3	AB	AB	R	NE	S
14	*Myrmarachne bengalensis*	175	AB	AB	AB	R	NE	S
15	*Platycryptus undatus*	12	AB	AB	AB	R	NE	S
16	*Plexippus paykulli*	3	AB	AB	AB	R	NT	S
17	*Plexippus petersi*	AB	7	5	5	C	NT	S
18	*Pseudicius picaceus*	AB	13	AB	AB	R	NT	S
19	*Telamonia dimidiata*	29	7	11	AB	A	NT	S
4. FAMILY: PHOLCIDAE								
20	*Pholcus phalangioides*	5	6	50	192	A	LC	IWB
5. FAMILY: TETRAGNATHIDAE								
21	*Leucauge argyra*	2	8	AB	AB	R	NE	OWB
22	*Leucauge decorate*	11	AB	12	2	C	NE	OWB
23	*Opadometa fastigata*	7	AB	2	AB	R	NT	OWB
24	*Tetragnatha mandibulata*	2	5	AB	AB	C	NT	OWB
25	*Tetragnatha montana*	3	AB	AB	AB	R	LC	OWB
6. FAMILY: SPARASSIDAE								
26	*Olios millet*	19	AB	AB	AB	R	NT	AM
27	*Heteropoda jugulans*	AB	5	AB	AB	R	NE	AM
28	*Heteropoda venatoria*	35	AB	AB	AB	C	NT	AM

Table 1. *Continued ...*

S. No.	Family / Species	No. of Individuals observed: Rural Habitats		Urban Habitats		FO	IUCN Status	Guild
		Vattipatti	Arasakulam	Thiagarajar College Campus	Kelavasal			
7. FAMILY: HERSILIIDAE								
29	*Hersilia savignyi*	AB	AB	6	AB	R	NE	FR
	Total Number of Individuals	**540**	**453**	**298**	**282**			
	Total Number of Species	**23**	**17**	**12**	**7**			
	SPECIES DIVERSITY							
	Shannon's index	2.23	1.97	1.35	1.11			
	SPECIES RICHNESS							
	Margalef's index	3.37	2.61	1.93	1.06			
	SPECIES EVENNESS							
	Pielou's index	0.46	0.42	0.32	0.23			

Abbreviation:AB: Absent; **FO:** Frequency of observation; **C:** Common; **A:** Abundant; **R:** Rare; **NE:** Not Evaluated; **LC:** Least Concern; **NT:** Near Threatened; **OWB:** Orb-web builders; **FR:** Foliage runners; **S:** Stalkers; **IWB:** Irregular web builders; **AM:** Ambushers.

cies in rural areas (i.e., Vadipatti and Arasakulam) were reported to be *Argiope anasuja*, *Cyrtophara cicatrosa*, *Cyrtophora citricola*, and *Myrmarachne bengalensis*. *Pholcus phalangioides, Gasteracantha geminata* and *Argiope anasuja* have been reported to be higher in urban areas (i.e., Thiagarajar College campus and Kilavasal). It's worth noting that the ant-like spider *Myrmarachne bengalensis* has been found in the Vadipatti area (Table 1).

In addition to ecological indices of species diversity (Shannon's), richness (Margalef's), and evenness (Pielous), the sites have shown variation with values of Vadipatti [Shannon's: 2.23; Menhinick's: 0.98; Margalef's: 3.37; Pielous: 0.45], Arasakulam [Shannon's: 1.97; Margalef's: 2.61; Pielous: 0.42], Thiagarajar College campus [Shannon's: 1.35; Margalef's: 1.93; Pielous: 0.32] and Kelavasal [Simpson's: 0.51; Shannon's: 1.11; Margalef's: 1.06; Pielous: 0.23). According to the present study, the highest spider species diversity, richness, and evenness indices were found in Vadipatti whereas the lowest were found in Kelavasal (Table 1).

Eight spider species are classified as "Threatened" by the IUCN categories, out of a total of 29 species: *Plexippus paykulli*, *Plexippus petersi*, *Pseudicius picaceus*, *Telamonia dimidiate*, *Opadometa fastigata*, *Tetragnatha mandibulata*, *Olios millet*, and *Heteropoda venatoria*. *Araneus mitificus*, *Neoscona theisil*, *Zygiella atrical*, *Oxyopes shweta*, *Pholcus phalangioides*, and *Tetragnatha montana* are among the five species listed as Schedule IV under the Wildlife (Protection) Act of 1972 and classified as Least Concern (LC) by the IUCN. The following eighteen spider species are listed in the IUCN Not Evaluated category: *Araneus dimidiatus*, *Argiope anasuja*, *Cyrtophora cicatrosa*, *Cyrtophora citricola*, *Gasteracantha geminate*, *Neoscona nautical*, *Peucetia viridians*, *Hyllus semicupreus, Menemerus bivittatus*, *Myrmarachne bengalensis*, *Platycryptus undatus*, *Leucauge argyra*, *Leucauge decorate*, *Heteropoda jugulans* and *Hersilia savignyi* (Table 1).

Discussion

The spider diversity, distribution, and their insect feeding habits are all important aspects in keeping the ecosystem balanced (Marc and Canard, 1997). In this study, a total of 29 species belonging to 22 genera and 6 families were identified in and around Madurai's selected habitats. The Vadipatti areas have the highest species diversity and richness, with

23 species belonging to six families. This habitat has a lot of floral (trees and bushes) and faunal diversity (butterflies, moths, beetles, dragon flies, and ants), which is important for building microhabitats for a wide variety of spider species. Higher species diversity, according to Hill (1973), is an indicator of a healthier and more complex community because a larger range of species allows for more interactions, which leads to greater system stability, which indicates good environmental conditions.

Based on their foraging mode, five functional groupings were identified in this study. With 48.27 percent, Orb-web builders were the most popular feeding guild, followed by Stalkers (27.58%). The feeding guild structure investigation by Adarsh and Nameer (2013) revealed five types of foraging functional groups in the spider fauna of Kerala Agricultural University and Pandit and Pai (2017) have documented nine foraging guilds in Taleigao plateau, Goa. Nyffeler *et al*. (1999) reported that orb-weaving spiders are the most abundant in agro-ecosystems; also, this web is particularly closed-meshed orb compared to other guilds, which could aid in the capturing of many small insects. The structure of spider guild is influenced by the host plant, microenvironment, and the level of disturbance (Uetz *et al*., 1999). The present study suggests that the complexity of vegetation's structure will help to sustain resources and encourage a greater diversity of spider species to form orb-web builders.

In the present study, the Araneidae and Salticidae families were dominant compared to that of other families. According to Ried and Miller (1989), agro-ecosystems with more structural complexity can support a more diverse spider community, particularly in the Araneidae and Salticidae families. In agcro-systems, the Araneidae and Salticidae families are frequently mentioned as accounting for a significant proportion of the spider family (Hagen and McMurtry, 1999). The results suggest that the changes in spider species diversity within families are certainly related to temperature, rainfall, humidity, prey species availability, other physical variables in the habitat, which could support to enhance the spider species diversity.

Although spider diversity, richness, and evenness differed among the study sites, Vadipatti had the highest Shannon's, Margalef's, and Pielou's index, while Thiagarajar College campus and Kelavasal had the lowest. According to Dash (1996), the higher the value of Shannon's index (H'), the greater the floral and faunal diversity (Malumbres-Olarte *et al* (2013). Culin and Yeargan (1983) employed species richness indexes to measure habitat quality and spider abundance in significantly human altered systems, which is supported by the current findings, which show a decrease in spider diversity as anthropogenic activities increase.

The spider species population density and relative abundance in agricultural fields can be as high as in natural ecosystems (Pawar *et al*., 2016). According to Jayaparvathi et al (2013), four spider species were found in cotton fields, including *Peucetia viridana*, *Oxyopes shweta*, *Oxypes salticus*, and *Peucetia latikae*, all of which are capable of controlling cotton pests. Faleiro *et al*. (1990) reported that the *Peucetia viridians* spider successfully suppress pest population of cowpea and soybean. *Peucetia viridians* and *Oxyopes shweta* species were only found in agricultural fields in the Vadipatti and Arasakulam areas. This finding shows that these two species could act as agricultural pest controllers. Furthermore, *Pholcus phalangioides* is only found in buildings in urban areas, which provide the spider with refuge, food, and a warm environment. This spider plays a vital role in regulating the expansion of insect populations in urban environments.

The significance of changes in spider community structure between urban and rural settings is evaluated through diversity analysis. In this study, it was revealed that spiders are abundant in rural habitats (Vadipatti and Arasakulam areas), which are agro-based environments, and that they regulate the population of insect and other macro arthropods, which may provide a suitable environment for spider species. In contrast, spider diversity was shown to be lowest in urban ecosystems as a result of industrialization, urbanisation, transportation activities, air and water pollution, and other factors intended to reduce spider populations. The present findings demonstrated that the spider species diversity and distribution in various ecosystems is increases with increased vegetation and decreases with increased human disturbances.

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