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Seasonal abundance, ecology and distribution of spider diversity in a semi-urban residential colony at Udumalpet, Tamil Nadu, India

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Abstract
Spiders hold a very ample amount of conservation importance and are under-explored. This study is not confined to a large extent in plot size and duration; it is limited to a preliminary level of data documentation. This research focuses primarily on spiders as the representative invertebrate fauna from this particular ecosystem. To provide a comprehensive overview of the baseline inventory of spider diversity in this study area, as well as to investigate biodiversity indices In the present study, 95 individuals of 36 species across 12 families have been recorded within the study period. Among the 12 families, the Araneidae family is the dominant family, comprising 10 species from 5 genera. The next dominant families are the Salticidae, comprising 9 species from 9 genera, followed by Lycosidae and Sparassidae, comprising 3 species each, Thomisidae, Theridiidae, and Oxyopidae, comprising 2 species each, and Lycosidae and Philodromidae, comprising 1 species each. The family Araneidae represents the most prominent family (27.7%), followed by Salticidae (25%), Lycosidae and Sparassidae (8.3%) each, Thomisidae, Theridiidae, and Oxyopidae (5.5%) each, and Gnaphosidae, Hersiliidae, Scytodidae, Tetragnathidae, and Theraphosidae (2.7%) each.

Keywords: spiders, seasonal abundance, biodiversity, semi-urban habitat, arachnids

Introduction

Tamilnadu has a plethora of varied bio-diverse regions with respect to the great species complex. Spiders' communities are spread in all ecological habitats, which play a vital role in maintaining ecological equilibrium owing to their high abundance and have exclusive insectivorous feeding habits (Wise, 1993; Nyffeler *et al.*, 1994a) [20, 13]. Spiders are present in varying habitats depending on different species. A few of them are indoor varieties, and some others are outdoor spiders. Indoor spiders live in quiet, undisturbed areas where moisture and food are available because the moisture content often attracts other bugs. Spiders have a vital role in balancing food webs and shaping the community structure among species. Hence, spiders are essential for the ecosystem too, as they eat bugs that affect our crops, such as aphids and caterpillars. In several habitats where they thrive, the pest crops have been regulated, thereby enriching the native biodiversity. It is undoubtedly clear that spiders are an integral part of global biodiversity in any major biome.

Spiders are considered biological indicators which have a great role in assessing the ecological conditions and also play an important role in the food chain. Although spiders are widely feared, only a few species are dangerous to people (Landova *et al.*, 2021) [6]. Spiders are carnivorous animals. They consume some arthropods, and their major preys are insects. The exclusive predatory behaviour of spiders has a notable impact on the ecosystem (Fathima *et al.*, 2021) [2]. It regulates insects' populations. Spiders construct webs to create their living habitats, in which most of the time they lie. Some spiders start spinning their webs at dusk and remain active throughout the night. Then they digest and detangle their own webs in the morning, which is crepuscular in nature (Levi, 2002) [8]. Most of them are web-braiding spiders, whereas some spiders hunt their victims on the ground (ground dwelling spiders). Web spiders are particularly sensitive to structural complexity. Spiders show dramatic morphological diversity and coloration. Generally, spiders are relatively small in size in domestic areas and some are big in size in forest areas (Giant Huntsman Spider-leg span of 12 inches). The small-sized spiders' body length is about 2–10 mm, and some giant tarantulas may reach a body length of 80–90 mm (Malhotra *et al.*, 2019) [10]. Male spiders are almost always smaller and have a shorter life span than females (Lietzenmayer *et al.*, 2019) [9]. Spider communities occupy the seventh position in total species diversity among all other assemblages of organisms (Sebastian and Peter, 2009) [15]. Spider communities may be found at different locations, such as house dwellings, grass leaves, among foliage, below fallen logs, under bark, underground burrows beneath stones, etc. The structural complexity of spider habitat is the linear function of spider diversity and abundance (Malhotra *et al.*, 2019) [10].

Vegetation quality regimes as well as habitat disturbances can be accounted for in spider diversity studies (Mithali and Pai, 2018) [11]. In different environments, parameters like the availability of prey, seasonal and temperature selection influence the occurrence of spiders. The density and availability of prey for a spider population determine the diversity. Vegetation assemblages also largely influence it with correspondence to seasonal changes (Krishnaveni *et al.*, 2017) [5]. Urban habitats are no exemption for spider populations to make it through, but there are many controversies associated with their survival in urban human-

dominated landscapes, either in direct or indirect ways. With respect to conducting spider diversity studies and species variation, it is found that the effects of rapid urbanization on spider communities are complex and require careful interpretation, which impacts directly on the major loss of spider diversity (Branco and Cardoso 2020) [1].

Home gardens with mixed plantations, use of chemical pesticides and insect repellents pose a serious threat to the spiders, as the chemicals could even accumulate in those eco-food chain systems. Conserving spider composition in household gardens lays the groundwork for future research into arachnids and bridges the gap between conservation planning and execution. Potential sites should be identified as gardens with natural habitats and can be promoted for the conservation of spiders. This documentation is important and holds crucial value in creating awareness about spider conservation within the scientific community as well as the general public. The distribution and level of occurrence of spiders in our homes, surroundings, and farm lands in this region is the first and baseline approach, thus providing data for future studies. The main objective of this study was to find out the seasonal abundance, ecology, and distribution of spider diversity patterns in a household garden ecosystem and the surrounding semi-urban residential colony.

Materials and Methods

Study Area

The present study was carried out at Udumalpet in the Tiruppur district of Tamilnadu, India. It is a city located near the foothills of the Western Ghats and blessed with copious water resources. The geographic coordinates of this landform are Latitude 10.58° North and Longitude 77.24° East, respectively, with an average elevation of 1198 feet above mean sea level. The topography slopes from west to north. The study area is a semi-urban residential colony with several private home gardens, avenue plantations, and has diverse natural vegetation supported by predominant species of trees. Spiders in varied ecological niches such as terrestrial and arboreal types surrounding the study area were selected and counted within their occurrence ranges.

Source: NRSC, Bhuvan Satellite image by ISRO

Fig 1: Study area

Methodology

The study was conducted from September-2021 to February-2022, covering parts of a seasonal course on monsoon and summer. A preliminary survey was conducted, and sites were randomly selected to locate prior trapping sites. Therefore, in order to maximise species richness from different microhabitats, extensive types of collection as well as trapping methods were conducted, like pitfall traps (for catching wandering ground spiders). These trap vials were kept empty without any fillings of anti-freezing agents, and those vials were half buried in soil and camouflaged with leafy litter. Spiders were collected using the vegetation beating method (for shrubs and high herb bushes) and sweep netting (for grasses and creepers). Hand picking methods are used to collect spiders from leaf-blades, flowers, and dry foliage. Transects were employed in different plots and sections. Transects were chosen in a random manner with semi-quantitative sampling methods to record spiders in the study area. By peering into leaf litter, rock crevices, soil burrows, and deadwoods such as fallen logs, twigs, barks, and debris, while arboreal spiders were also found in the remains of webs and retreats (curled, silken leaves) in tree trunks, undergrowth, and the middle canopy.

Apart from surveying methods, spiders that visit commonly in housing areas that were easily accessible were also included in the study. From September–2021 to February–2022, regular timely observations were made on a systematic basis of constant time of a minimum of 2 hours a day and thrice a week (to avoid data bias in sample count and species recapture). Survey walks were made to collect samples in the early morning (06:00 to 07:00 AM) and in the evening (17:00 to 18:00 PM) hours as many species of Araneae were crepuscular and were fully active in this part of the time. This helped generate significance in data collection and to assess the seasonality of species and to determine the abundance of species throughout the period of

study. No live/type specimens were collected during the entire period of study for reasons like species rarity of some peculiar spiders, endemic nature, and most importantly, to give due respect to the ethical beliefs in not causing any harm to live specimens. When a spider was located, it was immediately photographed in the field itself with a smartphone having a 32 megapixel camera and built-in macrophotography feature support, along with the aid of an APEXEL 100 mm 10 X Professional 4K Macro lens for the phone, mounted on a three-axis handheld gimbal stabilizer.

Nocturnal observations were also made. It was hard to precisely track the critters, so flash light was used with a macro diffuser to provide proper illumination when photographing the samples. Some species were collected for close examination. They were released into the same environment without causing any harm. Taxonomy and nomenclature for species identification followed as per Levi *et al.,* (2022) [7]; Sebastian and Peter, (2009) [15]; Tikader, (1987) [18], along with standard manuals and published literature, were highly helpful in species identification. The Shannon-Wiener (1949) [16] diversity index (H) was used to interpret the diversity of spiders from the sampled site, and the relative abundance for recorded spider species was calculated using PAST software and biodiversity pro software version 2.

Results and Discussion

A total of 36 species across 12 families were recorded in this study. The scientific name and common name of each spider were identified on the basis of distinguishing morphological characters and the structure of the genitalia given in Table 1 and figure 3. The guild structure analysis of the spiders revealed 7 types of feeding guilds based on the habits and habitats of spiders recorded in the study, which can be seen in Figure 2. The current study would hopefully serve to bring more urbanites into spider conservation, and this would create an awareness that is reflected in the protection and mapping of local biodiversity, especially for spiders. So far, spiders appear to be avoided by the general public due to irrational fear and cultural conditioning of false beliefs woven around them, such as being bitten or allergic to those organisms, which are widespread misconceptions. In the current study, a total of 95 species belonging to 36 genera under 12 families were recorded from the semi-urban residential colony of the Udumalpet region, Tamilnadu. Fathima *et al.,* (2021) [2] documented 93 species belonging to 71 genera under 19 families from different plantations in the Western Ghats, Wayanad, Kerala. Among the spider diversity, the maximum number of species was found in the Araneidae family, constituting 10 species from 5 genera, followed by the Salticidae with 9 species from 9 genera. The Lycosidae and Sparassidae families have three species each; Thomisidae, Theridiidae, and Oxyopidae have two species each; and Gnaphosidae, Hersiliidae, Scytodidae, Tetragnathidae, and Theraphosidae families have a single species each. The family Araneidae represents the most prominent family (27.7%), followed by Salticidae (25%), Lycosidae and Sparassidae have 8.3% each, Thomisidae, Theridiidae, and Oxyopidae have 5.5% each, and Gnaphosidae, Hersiliidae, Scytodidae, Tetragnathidae, and Theraphosidae have 2.7% each. These results were confirmed by the results of Vinay and Vivek (2021) [19] and Sidheek (2021). A similar study was carried out at Tumkur University Campus, Tumakuru, India, by Kokilamani *et al.,* (2019) [4], and spider diversity on Mangalore University Campus was observed by Sumangala *et al.,* (2018).

In India, which holds rich biodiversity, there is an urgent need to understand our spider communities closer to home. Maximum occurrences were noted in human habitats, and this might be due to lower predation chances and high resource availability for the spiders that live in urban habitats than in wild ones. During the present study, a total of 12 spider families were observed in this region. Among them are the Orb weaver, the Oval St. Andrews cross spider, the Signature spider, the Tent web weavers, the Pointillist neoscona, the Jumping spider, the mimicking spider, the housefly catcher, the wolf spider, the Huntsman spider, the Crab spider, the Indian grass lynx spider, the Red house spider, the Brown widow spiders, the Mouse spiders, the Tree trunk spiders, and the Brown spitting urban landscape units too have high biodiversity value and ecological significance, so this type of scientific information could enrich the existing conservation and management strategies in backyard biodiversity landscapes, as highlighted by Gajbe *et al.,* (2003) [3].

The semi-urban regions of this area recorded much species diversity in the months of September-2021 to February-2022 and the seasonal course of the monsoon. The observed species were calculated with the Shannon index formula and obtained a result value of H = 2.86, which falls within the optimum range of the index, indicating the quality of the study area ecosystem. It can be interpreted as this community of 36 populations identified for this study has shown the high diversity of this habitat within the framed period of study. The Shannon evenness value was obtained as E_H = 0.79, indicating that the habitat has an even distribution of species as the obtained value falls under the optimum range of Shannon evenness criteria, from which it can be concluded that the selected habitat within the duration of the study has high diversity and an even distribution of spider populations. As per the statement of Rain (2016) [14], the Shannon index results are within the range of 1.5 to 3.5. This means that the structure of the habitat is stable and balanced. Ngabekti *et al.,* (2021) [12] have observed the moderate spider diversity in the vast area of Kebun Wisata Pendidikan University Negeri Semarang, Indonesia, and they calculated the Shannon index value obtained as H = 3.65, which is a high value compared to our results. Also, they confirmed that the diversity value was influenced by the evenness index, which was E_H = 0.86 and these results confirmed that rich spider diversity was obtained in the study area. The study revealed that spider diversity is influenced by the type of habitat, vegetation, and environmental disturbances. Unlike the other ecologically important eco-zones like the Western Ghats in Tamilnadu, which have the most diverse and abundant biotic features, the present study area sampled in the monsoon season had a wide variety of unique microhabitats and those arrays of mixed habitats exhibited high levels of heterogeneity, thereby providing different microclimatic zones and alternative food sources that might have favoured the spider's survival.

Conclusion

The present study it has been concluded that Semi-urban residential colony at Udumalpet, Tamilnadu, has a moderate diversity of spider species with 95 spiders belong to 36

genera of 12 families with in the season. The spiders recorded in this study compared to other studies can be related to fumigation usually carried out on household areas as well as people's perception of spiders as human enemies, which could also be a factor for changing spider diversity. All of this data is used to learn about the spider species colonization present in these areas for future research. This kind of study provides necessary resources for policy making and to obtain a legal conservation status for spider species. This study lays the foundation and aids for other such studies by deploying additional collection methods in contrast with different seasonal attributes that have been investigated.

The present study might be beneficial to catalogue the poorly documented spider fauna and perhaps to influence the discovery of new species along the way.

Table 1: Spiders recorded during the study

S.No	Family	Scientific Name	Common Name
1	Araneidae	*Araneus cavaticus*	Barn orb weaver
		Araneus marmoreus	Marbled orb weaver
		Araneus ventricosus	Round orb weaver
		Argiope aemula	Oval St. Andrews cross spider
		Argiope pulchella	Signature spider
		Cyrtophora citricola	Tent web weavers
		Neoscona crucifera	Hentz orb weaver
		Neoscona punctigera	Pointillist neoscona
		Neoscona scylla	Black spotted orb weaver
		Thelacantha brevispina	Asian spiny backed orb weaver
2	Salticidae	*Carrhotus viduus*	Jumping spider
		Chrysilla volupe	Rainbow jumper
		Hyllus semicupreus	Heavy bodied jumper
		Menemerus bivittatus	Grey wall jumper
		Myrmarachne melanocephala	Bicolour Ant mimicking spider
		Pleippus paykulli	Pan tropical jumper
		Plexippus petersi	Common housefly catcher
		Telamonia dimidiata	Two striped jumper
		Thyene imperialis	Jumping spiders
3	Lycosidae	*Hippasa agelenoides*	Funnel web wolf spider
		Lycosa bistriata	Huntsman spider
		Pardosa pseudoannulata	Thin legged wolf spiders
4	Sparassidae	*Olios lamarcki*	Tropical huntsman
		Olios milleti	Green crab spider
		Heteropoda venatoria	Pan tropical huntsman
5	Oxyopidae	*Peucetia viridana*	Indian grass lynx spider
		Oxyopes javanus	Grass lynx spiders
6	Theridiidae	*Nesticodes rufipes*	Red house spider
		Latrodectus geometricus	Brown widow spiders
7	Thomisidae	*Thomisus labefactus*	Masked crab spiders
		Thomisu spugilis	Flower crab spiders
8	Gnaphosidae	*Scotophaeus blackwalli*	Mouse spider
9	Hersiliidae	*Hersilia savignyi*	Tree trunk spider
10	Scytodidae	*Scytodes fusca*	Brown spitting spiders
11	Tetragnathidae	*Leucauge decorata*	Long jawed orb weavers
12	Theraphosidae	*Plesiophrictus millardi*	small burrowing tarantula

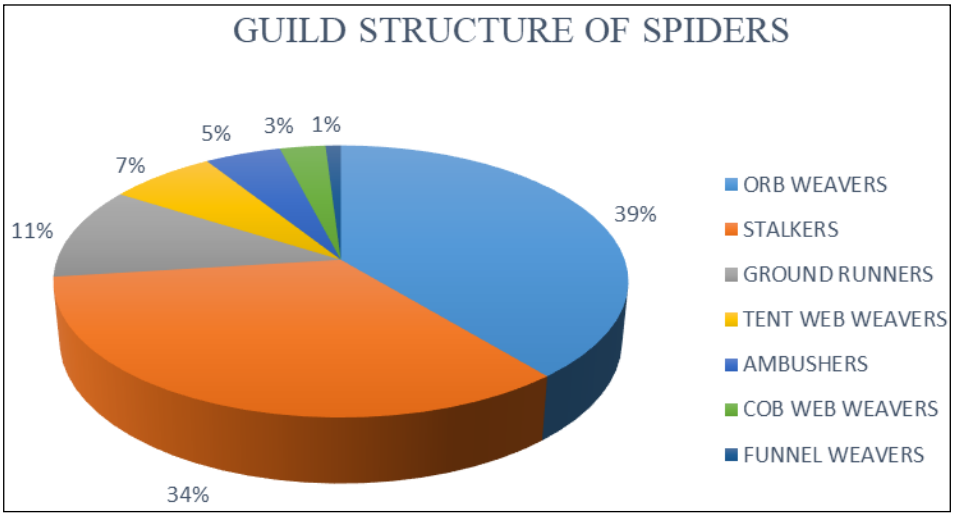

Fig 2: Chart showing guild structure of spiders

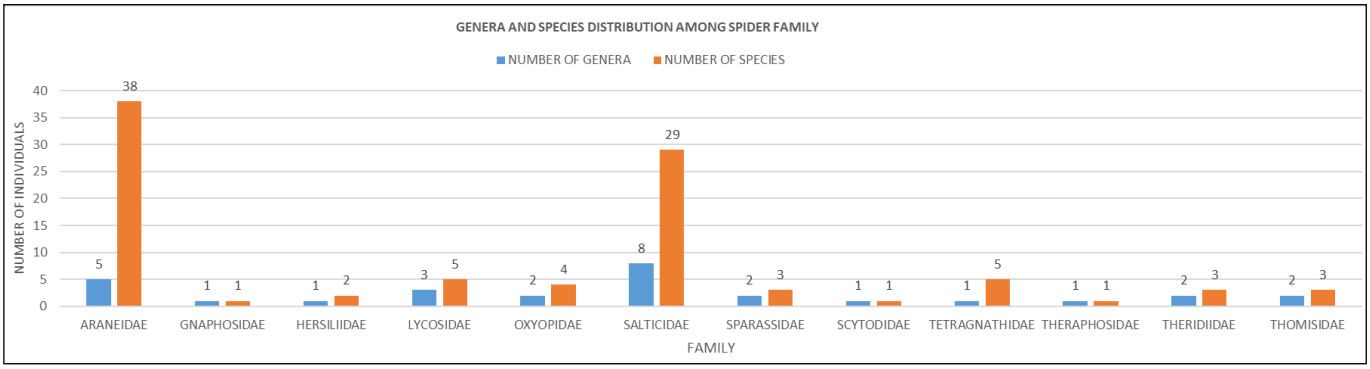

Fig 3: Graph showing genera and species distribution among spider family

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