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Research Article

Analysis of Web Pattern of Selected Orb Weaving Spiders

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Abstract | Spiders that spin spiral wheel-shaped webs are included in the family Araneidae. Sree Kerala Varma College, Kerala was selected as the study area for analysing the web patterns of selected spider species of the family Araneidae *Argiope anasuja* Thorell.1887 and *Cyclosa confraga* Thorell 1893 in natural and laboratory conditions. The web parameters number of radii, spirals, hub spirals, and diameter of the web were directly observed, measured and readings were noted. Capture area of each web was calculated. The results showed changes in all parameters in both natural habitat and laboratory conditions. The diameter and other parameters changed according to the microhabitat changes. Changes in parameters also affected the capture area. This study is an evidence which indicates the changes in the habitat by both biotic and abiotic factors can directly affect the behaviour of spiders and it can be visualized from their web pattern.

Keywords | *Argiope anasuja*, Behaviour, Capture area, *Cyclosa confraga*, Web pattern

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INTRODUCTION

Spiders can be found in nearly every terrestrial habitat, from the highest mountain peaks to the deepest caves and holes, from wet swamps to deserts. They are considered as the prospective biological control agents. They eat almost all insects, although their potential application in insect pest control has little attention (Riechert and Lockley, 1984).

Family Araneidae is one of the dominant families in the order Araneae. It is the third largest spider family in the world. 3,150 identified species in 184 genera have been reported from the family Araneidae (WSC, 2024). In India, there are 198 species belonging to 38 genera and 5 subfamilies of this family are present.

The spiders in Araneidae family vary greatly in size as well, some species of *Singa* are about 2mm in length while some of the *Nephila* can grow to over 50 mm, even killing small birds. A great variety of orb web designs exists due to this great variety of species. Araneid webs are studied with glue droplets while the others are not (Foelix, 1982). Orb weavers will only bite if they feel threatened and trapped without a chance for escape.

Araneidae is the most community group of builders of spiral wheel shaped webs. All orb weavers spin some sort of web having concentric circles. The smaller circles within the larger circles, with spokes radially going from the centre outwards towards the anchor points.

Theridiidae and Pholcidae family members made irregular webs. Linyphiidae built sheet web and the main section of it is made up of a more or less tightly sheet that is stretched in a single plane. The webs of common grass spiders are funnel web. Triangular web is built by *Hyptiotes*. Spiders use silk not only for food capture, but also for protecting their young, building houses and moving about. Spiders differ from any other animal on earth in using silk in practically every aspect of their life. Various spider species construct distinct patterned webs (Reed and Witt, 1968). One can easily analyse and study the web building behaviour of spiders. The web building behaviours are influenced by the physical surroundings. Many studies shows the behaviour thermoregulation is influenced by solar direction.

Cyclosa confraga shows not any significant changes in the web's size in both natural and laboratory conditions, unlike *Argiope anasuja*. In the case of *Cyclosa confraga* space doesn't seems to be constraining factor. In both natural habitats and laboratory condition, the web build by *Cyclosa confraga* is smaller when compared to *Argiope anasuja*.

The present study is conducted to analyse the web pattern of selected species of family Araneidae, to compare the web pattern of selected species in natural and laboratory conditions, to compare the capture area of the web build in the natural and laboratory conditions and to understand the factors affecting the web spinning behaviour of the two species.

Review of literature

It is believed that, spiders have been evolved from an arachnid ancestor around 400 million years ago during the Devonian period (Turnbull, 1973; Selden *et al*., 1991). Spiders are common generalist predators in ecosystem, having an important role in the biological control of pest species (Schmidt and Tscharntke, 2005). Species have been suggested to be an ideal group for predicting extinction debt in other taxa due to habitat destruction.

Griswold *et al*. (1998) studied the phylogeny of orb web building spiders. He has done a phylogenetic analysis of 31 model taxa which treated 12 families of Araneoidea. Reed and Witt (1968) worked on the progressive disturbance of spider web geometry caused by two sedative drugs; diazepam and phenobarbital. In the effects of diazepam and phenobarbital on web-building, there have a time and dosage dependence.

Zschokke (1996) studied the spatial and temporal pattern of capture web building behaviour in distinct species of orb web weaving and non-orb web weaving genera. They found that, capture spiral tracks are not spaced evenly but it is bundled around the auxiliary spiral for various species, the bundling seems to be varying. Zschokke (1996, 1999) studied the early stages of orb web construction in *Araneus diadematus*. The costs of exploring a new site versus adapting and re-building an existing web were contrasted.

Venner *et al*. (1999) studied the web building behaviour in the orb weaving spider *Zygiella x-notata*. They evaluated capacity of *Z. x-notata* and observed the changes in its construction behaviour in response to several stages of predation (prey detection, capture, and ingestion) encountered with a prior web in the lab.

Benjamin and Zschokke (2000) developed a computerized method to observe spider web building behaviour in a semi-natural light environment. Using an infrared sensitive digital video camera, live pictures re captured, and sent to a computer where they are analysed in real time. A different software allows for a more in-depth examination of the recorded motions, as well as numerous geographical and temporal studies.

MATERIALS AND METHODS

The study was carried out for a period of three months from April, 2022 to June, 2022. Sree Kerala Varma College, Kanattukara, Thrissur was selected as study area for understanding the web patterns of selected spider species of the family Araneidae in natural conditions. Sree Kerala Varma College is a semi residential college, blessed with rich flora and fauna.

Species selected for the study were *Argiope anasuja* and *Cyclosa confraga. Argiope anasuja* (Figure 1).

Figure 1: *Argiope anasuja.*

Cyclosa confraga (Thorell, 1892) (Figure 2) is the common *Cyclosa* spider. There is no scape on its epigyne, but it has a large bulging shape (Sebastian and Peter, 2009).

Figure 2: *Cyclosa confraga.*

Various web parameters including number of radii, spirals, hub spirals and diameter were measured and readings were recorded. By gentle tapping on the spider or by gentle tapping on the web without causing any damage to the web, the spiders were resting on the hub were removed during the observation. The same spider were spotted again in the next day and readings were measured and recorded. The procedure repeats for both spiders. For the web analysis *Argiope anasuja* and *Cyclosa confraga* were chosen. After spotting one spider, their web was observed for 6 days continuously and three readings were noted. Details of 3 specimens of each species were collected. So total nine readings were taken for each species. They were identified with the help of available literature. These spotted spiders for the analysis of web structure in natural condition were also used for the laboratory analysis of web patterns.

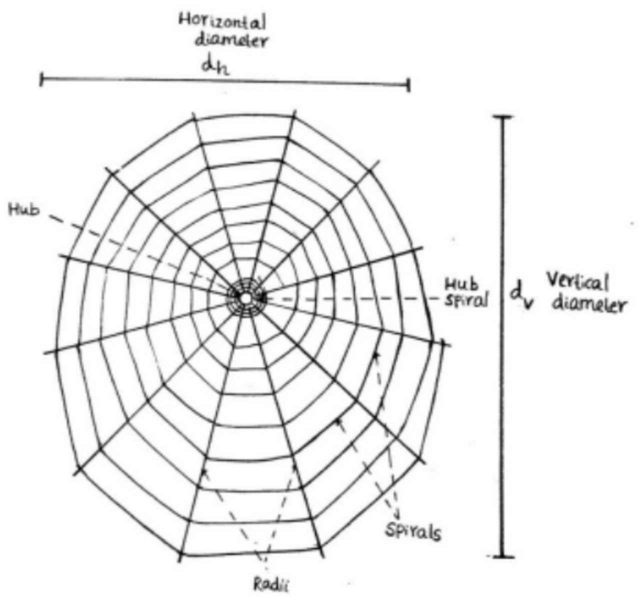

Figure 3: Orb web showing the parameters observed in the study.

Before capturing and releasing the spider, cages were prepared and well maintained in the lab. Cuboidal shaped boxes, with four rectangular and two square faces, measuring (45cm×32cm×25cm) were used as cages. The wooden frames of the cage was first prepared. All four rectangular faces and one square face were covered with black paper. Covering the cage with black colour was to make the visibility of the silk threads in the web easier during the observations. The remaining uncovered square face were covered with finely meshed polythene net in such a way that the net can be opened upwardly. The spiders were released in to the cage through this face. Also feeding, watering and opening cage for observations were done through this face. Small plant and twigs were provided inside the cage as a support for the spiders during the web building inside the cage.

After the observations and collecting data from natural habitat and laboratory capture area of each web were calculated. To calculate the capture area of the webs, Ellipse formula was used (Herberstein and Tso, 2000). The Ellipse formula assumes an Elliptical calculation of the web and considers both radii from horizontal and vertical diameter respectively and includes hub area in its estimation.

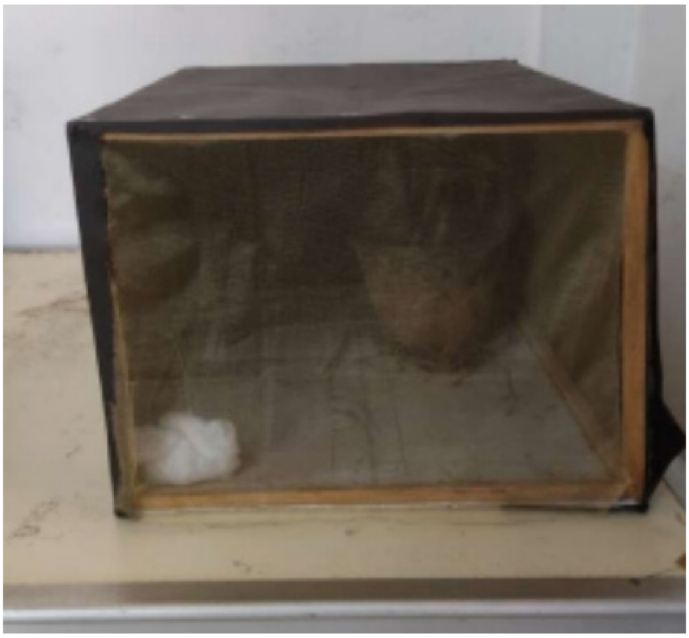

Plate 1: Cage used to maintain spiders in the lab

RESULTS

Major difference found in the web of specimens in the natural habitat and laboratory conditions was the size of the web. In the natural habitat the web was larger and the number of radials and spirals were more. Features were not changed significantly after each day's observation in all three specimens. In the cage, size of the web reduced significantly. There were significant changes in the number of spirals and radials when compared to the natural habitat. Another major difference observed was the change in the stabilimentum. In natural habitat X-shaped stabilimentum was observed in the web. But a prominent stabilimentum was absent in the web built by the spider within the cage. In both conditions the spider was resting in the centre hub of the web in an inverted position. Another significant observation was the reduction in the number of spirals in the web after each day when the spider was maintaining in the laboratory conditions.

In the species 1 (*Argiope anasuja*) there is significant changes in the capture area of the web build in natural habitat and in the cage. Whereas in species 2 (*Cyclosa confraga*) a notable difference in the capture area was not observed.

Drawings of the webs of each species observed in both conditions are given below.

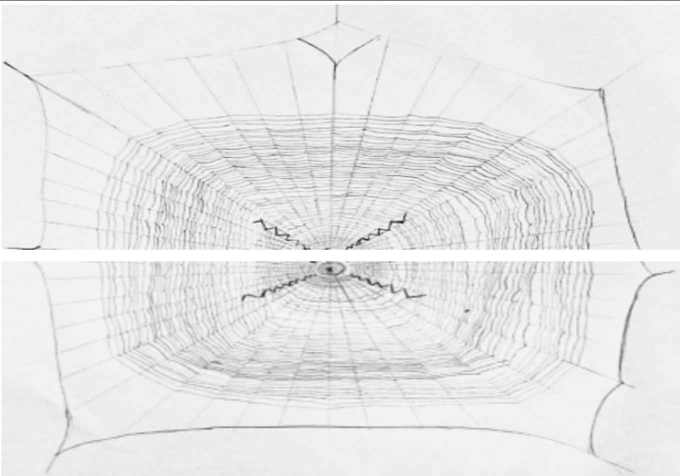

Figure 4: Web of *Argiope anasuja* in natural habitat.

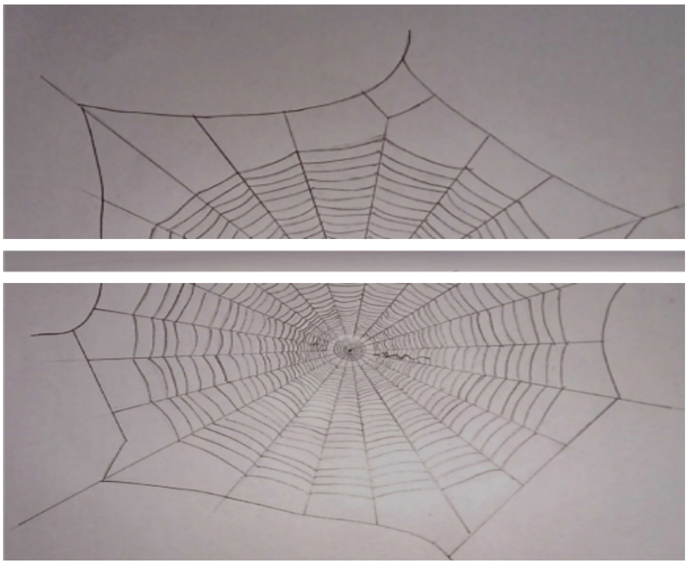

Figure 5: Web of *Argiope anasuja* in laboratory conditions.

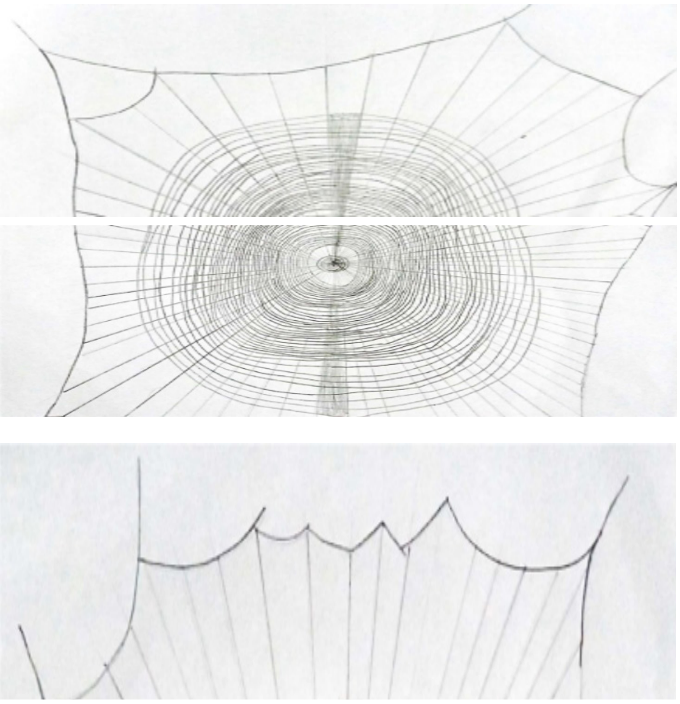

Figure 6: Web of *Cyclosa confraga* in natural habitat.

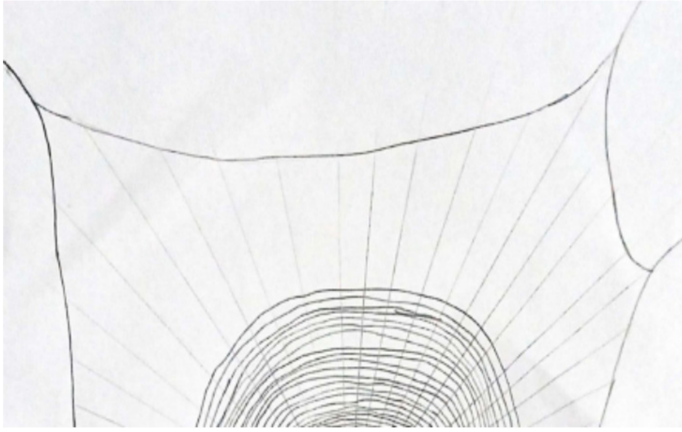

Figure 7: Web of *Cyclosa confraga* in laboratory conditions.

DISCUSSION

Because of the unique weaving capacity to organize geometrical precision and beauty of the web, spiders grabbed the attention of naturalists. Araneidae have cosmopolitan distribution due to their diversified forms and habits. The study on silk web architecture is very scanty. Web construction and its design is the integral unit of behaviour in orb web spiders. Orb weaving spiders serves as a great model for the study of different questions in behaviour and ecology as the measurement of the architectural features of webs helps to quantify and compare many aspects of spider behaviour. Studying architectures of spider webs provide insight on how spiders defy selective pressures in their environment.

The present study carefully observed and analyzed the webs built by two species of the family Araneidae: *Argiope anasuja* and *Cyclosa confraga*, in both natural habitat and laboratory conditions. Parameters such as number of radii, number of spirals, number of hub spirals, vertical and horizontal diameter were considered to analyze the web patterns of the two species. Capture area of each webs are estimated with the data obtained. The spiders were spotted at Sree Kerala Varma College, Kanattukkara, Thrissur. The webs of three specimens each for *Argiope anasuja* and *Cyclosa confraga* was observed and analyzed in the natural conditions. The spiders were collected by hand picking method into collecting bottles and released into a cage previously made in the laboratory. The web constructed by each specimen was observed and analyzed in the cage. Using the data, the capture area for each specimen was calculated.

In the present study, A*rgiope anasuja* build smaller webs in the cage than from natural habitat, there is a variation in the web parameters. In the natural habitat, the web build by *Argiope anasuja* was larger and the number of radials and spirals were more. But in the cage it builds smaller webs when compared to natural conditions. This is because, in the natural habitat they got enough space to build the web and the web is used by them to capture their prey. In the cage, the spider don't get enough space to build the web. And also we provided the food periodically for spider, so it is not necessary to build larger webs like natural habitat.

Another striking change observed was the change in the stabilimentum. X-shaped stabilimentum was observed in the natural habitat. But in the cage a proper stabilimentum was absent. The major use of stabilimentum is to attract the prey and to avoid predators. Hence in the natural condition a prominent stabilimentum can be observed. Predators are absent and the spider was fed periodically when they are in the cage. Hence stabilimentum is insignificant inside the cage. This might be the reason for not creating a proper stabilimentum while the spider is inside the cage. Number of spirals after each day when the spider was maintained in the laboratory conditions were reduced significantly. In natural habitat the number of spirals after each day stood similar with minor changes. In the natural habitat the number of sticky spirals will be more and have very small mesh size. Spider is not getting the prey periodically in the natural habitat. But in the cage it is different. The spider was fed periodically. The feed was kept in the web so that the process of prey getting caught in the web had less relevance inside the cage. The major role of sticky spirals is to capture the preys coming into the web. But in this situation sticky spirals have not had much relevance.

Changes in one's physical state may affect web development. Spiders' web-building behaviour and the amount of silk they consumed in the short term were plastic (Venner *et al*., 1999). Information obtained during prey capture appeared to influence the size and structure of the subsequent web. The spider detect prey via airborne vibrations, before they webs and the presence of a prey had an influence on web building.

The present study focused on the web patterns of two selected species belonging to the family Araneidae, and also on the variations of web pattern of the spider when they are maintained in laboratory conditions. The results of the study support the literature that, spider shows variations in its web pattern by altering the web parameters as the environment around them changes. In the case of *Argiope anasuja* there is a variation in the web parameters. In the natural habitat, the web was larger and the number of radials and spirals were more. But in the cage, the size of web reduced significantly. There were significant changes in the number of spirals and radials when compared to the natural habitat. But *Cyclosa confraga* did not exhibit any significant change in the space inside the cage. It showed changes only in the nature of stabilimentum. In natural habitat the stabilimentum is well developed and in the cage, it is less prominent. Thus the study supports that the changes in the environment around spider due to both biotic and abiotic factors directly affects the behaviour of the organism and it is visualized through the variations in the web pattern.

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NOVELTY STATEMENT

This paper describes the web pattern of orb weaving spiders *Argiopa anasuja* and *Cyclosa confraga*. This work represents original research and has not been previously published in research journals. Their web parameters, no of radii, spirals and web diameters were measured and analysed in both natural and laboratory conditions. We deeply appreciate your consideration for publishing the manuscript in your esteemed journal.

AUTHOR'S CONTRIBUTION

The concept of this topic was suggested by the first author. The work part was done by the pg student at shadpahda, centre for taxonomy research at christ college, irinjalakuda data collection, drawings were done by the student and drafted the research paper under the supervision of the first author.

Conflict of interest

The authors have declared no conflict of interest.

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