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Study on Structure and Types of Spider Webs from Nagpur District Maharashtra India

Sonu G. Thawkar [*] and Sharyu V. Ghonmode [**]

[*] P. G. T. D. RTMNU Nagpur University, Nagpur
[**] Shri Shivaji Education Society, Amravati's Science College
Congress Nagar Nagpur-440012

Abstract

The structure of spider webs varies substantially between species, and web building has even been lost completely in some clades. Examples of different web forms include the classic orb webs, which may be oriented vertically to the ground or horizontally, sheet webs, and cobwebs, consisting of three-dimensional meshwork and ascending sticky threads for support and capture of prey. The primary function of spider webs is to capture prey. This ecological success is in part due to the exceptional mechanics of the spider web, with its strength, toughness, elasticity, and robustness, which originate from its hierarchical structures from sequence design to web architecture. Hence a preliminary survey was carried out to structure and identify types of spider webs from Nagpur district, Maharashtra, India. This study explores the structure and identification of spider webs (Arachnids) in the Nagpur District of Maharashtra. Sampling was carried out in 8 months from January 2024 to August 2024 during the weak and month wise. Spider webs are collected using a Photograph collection and black paper for the collection of type's spider webs. The results of the study concluded that a total of 8 types of spider webs were collected there were Site A 3 types of spider webs, Site B 3 types of spider webs, Site C 1 type of spider web and Site D 1 type of spider web were identified. A total 8 types of spider webs are identified, the names of types of spider webs are the total 8 types of spider webs Identified in Nagpur district the following types of spider webs are the Funnel-web of spider, Sheet web, Classic round webs of spider webs or Orb webs, Mesh web of a spider, Cobweb of spider, Tangle web, Messy web of a spider, and Triangle web of spider.

Keywords: Spider, webs

Introduction

Studying the secrets behind the high-strength nature of spider webs is very challenging due to their miniature size. The study sheds light on spider web utilization to develop an optimized fiber orientation reinforced composite structure for constructing, for instance, shell structures (Regassa Yohannes, *et al.,* 2021). The geometric complexity and stereotypy of spider webs have long generated interest in their algorithmic origin. Like other examples of animal architecture, web construction is the result of several assembly phases that are driven by distinct behavioral stages coordinated to build a successful structure (Corver Abel, *et al.,* 2021). Web spiders on vibrations propagated via their web to identify, locate and capture entangled prey. Here, the portion of what is known about spider web diversity, evolution, ecology, and building behaviors is a consequence of over a century of detailed observations on Neotropical spiders (Blamires Sean J, *et al.,* 2017). The slight variation in the geometry markedly we experimentally tested the robustness of the orb weaver's predation strategy when webs are severely distorted and silk tensions are drastically altered throughout the web, a common occurrence in the wild (Mulder Tom, *et al.,* 2020). Spiders have optimized and adapted their web architecture by providing housing, protection, and an efficient tool for catching prey. The most studied web in literature is the two-dimensional (2D) orb web, which is composed of radial and spiral threads (Krell Adarian, *et al.,* 2018). Web building has been such a highly successful foraging innovation among spiders that the vast majority of extant spiders are web builders. A significant affects the prey-capture ability of spider orb webs. The study is focused on the secondary frame, a thread interposed between radial and primary frame strands (Soler Alejandro and Ramón Zaera 2016). Spiders spin intricate webs that serve as sophisticated prey-trapping architectures that simultaneously exhibit high strength, elasticity and graceful failure. To determine how web mechanics are controlled by their topological design and material distribution, here we create spider-web mimics composed of elastomeric filaments (Buehler Markus J, *et al.,* 2015). Spiders evolved to make more complex spiralling orb webs, in which different regions are composed of different kinds of silk some optimized for capturing prey, others for structural support of large web designs (Bourzac Katherine 2015). Not all spiders build webs to catch their, largely, insect prey, but those that do are responsible for some of the most iconic and beautiful structures in the living world. Katty Baird explored the magic of the Garden Spider orbweb in 'Wonderfully Woven Webs' (Oxford Geoff 2015). Webs provide spiders with a means to trap their food and, in some cases, a place to shelter. Webs consist of blends of different silks, cleverly combined for functionality. Take the 'typical' orb web of the common garden spider (compare the photo on this page), which has evolved to take out-of-plane loads at optimized deflections (Vollrath Fritz 2014). Spiders build their webs with a material called silk. Spider silk contains protein fiber that has many advantages and functions. One of them is to capture their prey such as flies, insects, and others (Kabbashi N. A. *et al* 2012). Orb-web spider dragline silk is the focus of intense research by material scientists attempting to mimic these naturally produced fibers.

However, biomechanical research on spider silks is often removed from the context of web ecology and spider foraging behavior (Aaron M. T. *et al.*, 2010).

Study Area

The study was conducted in Nagpur district, Maharashtra, India. The following sites were used for the study. Site A- Nagpur, Site B- Mouda, Site C- Ramtek, Site D- Kamptee.

Site A Nagpur: Nagpur district of Maharashtra also known as the city of Oranges. Nagpur is the third largest city in the Indian state of Maharashtra. The total area of Nagpur is 9,892 km² Nagpur district including 9,409.05 km² rural area and 482.95 km² urban area. The average annual rainfall in the district is 1100 mm (43.3 inches). During summer, the mean daily maximum temperature is 35.4°C and the minimum is 29.3°C and it decreases toward winter with a mean daily maximum temperature of 30.6°C and a minimum of 16.2°C. It has a garden area from RTMNU Nagpur University.

Site B Mouda: Mouda is a town and Tehsil in the Nagpur district of Maharashtra. The total area of Mouda Tehsil is 619 km² including 606.36 km² rural area and 13.06 km² urban area. Mouda is 50 kilometers away from Nagpur. Mouda includes 314 Villages. It has agricultural areas, and a significant number of industries (Dal mil company, Rice mil company and Thread company are found in Mouda tehsil.

Site C Ramtek: Ramtek is a town and Tehsil in the Nagpur district of Maharashtra. The total area of Ramtek Tehsil is 1,168 km² including 1,157.54 km² rural area and 10.71 km² urban area. The Ramtek is 56 kilometers away from Nagpur. Ramtek includes 156 Villages. It has an agricultural area and a forest area.

Site D Kamptee: Kamptee is a town and Tehsil in the Nagpur district of Maharashtra. The total area of Kamptee Tehsil is 402.88 km² including 365.74 km² rural area and 37.14 km² urban area. The Kamptee is 15 kilometers away from Nagpur. Kamptee includes 77 Villages. It has an agricultural area.

Materials and Methods

Study Area (Nagpur and other selected Sites Mouda, Ramtek, Kamptee).
Survey Method- Weekly, Monthly,
The used for following methods for photograph collection and using black paper
Image Capture the spider web images from uncontrolled environments were taken. Once the image-capturing tool has captured the spider web image. This is an approach used to collect data or real pictures of the web and prepare the study samples, and it involves the following Collecting real pictures for spider webs as a study sample.

Methodology

To study the structure of spider webs, a survey was conducted for 8 months from January 2024 to August 2024. This included 4 sites.
Site A- Nagpur, Site B- Mouda, Site C- Ramtek and Site- D Kamptee.

Photography and Identification

The data and location of the collection were noted and the other morphological features were observed clearly and noted. All spider specimens were identified referring to the taxonomic keys. After taking the photograph of collected spiders they were released into their natural habitats.

Result and Discussion

The study conducted at Nagpur district discovered a total of 8 types' webs of spiders were found from Site A 3 types of spider webs, were found from Site B 3 types of spider webs were found from Site C 1 types of spider webs and were found from Site D 1 types of spider webs. Types of spiders were collected by using for following methods for photograph collection and using black paper, Image Capture the spider web images from uncontrolled environments were taken. Once the image-capturing tool has captured the spider web image. This is an approach used to collect data or real pictures of the web and prepare the study samples, and it involved the following Collecting real pictures for spider webs as a study sample. A total 8 were types of spiders were Identified from the Nagpur district including the following types of spiders webs are the Funnel-web of spider, Sheet web of a spider, Classic round webs of spider webs or Orb webs, Mesh webs of a spider, Cobwebs of spider, Tangle web, Messy web spider, Triangle web spider. Site-wise types of spider webs were identified from Nagpur district. The 3 types of spider webs were identified from site A Nagpur, 3 types of spider webs were identified from site B Mouda, 1 types of spider web were identified from site C Ramtek, and 1 types of spider webs were identified from site D Kamptee (Table 1).

Nagpur District provides a diverse habitat for various spider species. A total of 8 types of spider webs spiders representing 6 families were recorded from the Nagpur district which includes. During the study period, Theridiidae is the most representing family. In the present study individual family to belonging Lynyphiidae, Agelenidae, Dictynidae, Uloboridae, Araeneidae and Theridiidae. The spider webs include families Funnel web of Spider family Agelenidae species Funnel weaver spider or Grass spider, Sheet webs of spider family Lynyphiidae species Sheet weaver spider, Classic round webs of spider webs or Orb webs family Araeneidae species Araneus diadematus, Mesh web of spider family Dictynidae species Dictyna arundinacea, Cobweb of spider family Theridiidae species Black widow, Tangle web family Theridiidae species Black widow, Messy web of spider family Amaurobiidae species cellar spider and Triangle web of spider family Uloboridae species steatoda triangulosa. (Table 2).

The structure types of spider webs are described:

Funnel Web: A funnel web is built in the grassland areas. The spider hides at the small end and rushes out and grabs the insects as they come down the funnel. Funnel-web spider is any of a group of spiders that make funnel-shaped webs, which they use to trap insects. They are among the most abundant and conspicuous spiders in temperate grassland areas. They are also known as grass spiders. Worldwide there are about 700 known species of funnel web spiders. The families like Agelenidae and Lyniphidae show funnel type of web pattern formation. (Figure 1). **Sheet Web:** A flat sheet web with main lines running down the center. When any insect lands on a sheet web, the spider shakes it, causing the insect to struggle and get caught in the strands. The principal part of the web of a more or less closely woven sheet extended in a single plane and consisting of threads extending in all directions in that plane. These webs are found on two adjacent walls. Linyphiidae family shows the sheet type of web formation. Families like Filistatidae and Lyniphidae show irregular types of web pattern formation. (Figure 2). **Orb webs:** An orb web is shaped like a circle. The characteristic feature of an orb-web is that the center portion, the part laying within the supporting framework, consists of a series of radiating lines the web of Aranidae is an excellent illustration of this kind of web. The typical orb-weaver spiders (family Araneidae) are the most common group of builders of spiral wheel-shaped webs often found in gardens, fields and forests. The 3,006 species in 168 genera worldwide make Araneidae of spider diversity (Figure 3). **Mesh webs:** Spiders in the family Dictynidae are small, sedentary arachnids that build irregular mesh webs to snare prey, and as shelters for themselves. The spider begins by spinning a simple framework of parallel rows, then overlapping those with another set at the right angle the Dictynidae family is responsible for mesh webs (Figure 4). **Cobwebs:** Cobwebs are spider webs that are known for being messy, irregular, and three-dimensional. Cobwebs are often found in corners, under furniture, or in less-disturbed areas. Cobwebs are typically anchored to multiple points, allowing them to cover larger areas with seemingly random threads. Cobwebs are designed to capture prey that gets entangled in the sticky silk threads. Cobwebs are also good at collecting dust. Families like Theridiidae (Figure 5). **Tangle webs:** Primarily made by spiders in the Theridiidae family. This family includes very common and harmless house spiders. Tangle web spiders are a large group of spiders that build tangled webs and are known for their ability to lift prey that is much heavier than themselves. Tangle web spiders build messy, irregular webs that are often found in sheltered places and houses. Families like Theridiidae (Figure 6). **Messy webs:** This includes various types of webs, spatial and somewhat disorderly appearance. Messy silk together with threads that are tightly stretched against the surface. These threads have small adhesive droplets. If a crawling insect gets stuck, the thread detaches and the prey is lifted off the ground. Families like Amaurobiidae (Figure 7). **Triangle webs:** Triangle webs are built in the shape of a triangle vertically. There are typically four main anchor points, with one on one side and three on the other. Three strands of silk are connected with thread to create a very simple web. While these webs are unique in

their design, they're even more unique in their function. The Uloboridae family of spiders is associated with this type of web (Figure 8).

Table 1: Site-wise types of spider webs Number counts from Nagpur district

Sr. No	Types of Spider webs	Site A Nagpur	Site B Mouda	Site C Ramtek	Site D Kamptee
1	Classic round webs or Orb webs	1			
2	Sheet web	1			
3	Funnel web	1			
4	Mesh web		1		
5	Cob web		1		
6	Tangle web		1		
7	Messy web			1	
8	Triangle web				1

Table 2: Site wise types of spider webs were identified from Nagpur district

Sr. No.	Types of Spider Webs	Species	Family
1	Classic round webs or Orb webs	Araneus diadematus	Araneidae
2	Sheet web	Sheet weaver spider	Lynyphiidae
3	Funnel-web	Funnel weaver spider or grass spider	Agelenidae
4	Mesh web	Dictyna arundinacea	Dictynidae
5	Cobweb	Black widow	Theridiidae
6	Tangle web	Black widow	Theridiidae
7	Messy web	Cellar spider	Amaurobiidae
8	Triangle web	Steatoda triangulosa	Uloboridae

Types of spider webs structure and Identification of spider webs.

Figure 1: Funnel web of spider

Figure 2: Sheet web

Figure 3: Classic Round webs of spider webs or Orb webs

Figure 4: Mesh web of spider

Figure 5: Cob web of spider

Figure 6: Tangle web

Figure 7: Messy web of spider

Figure 8: Triangle web of spider

The study indicates that the Structure and identification of spider webs study in the Nagpur district, were observed from 8 types of spider webs, species and families with structure of spider webs and identification of Nagpur district. Another research on the study was recorded. According to their web-building 'ability, generally, spiders are considered as weavers or non-weavers Present paper describes the web architecture and patterns of spiders for their diversity and distribution in the habitat of Eastern Rajasthan. There are more than 30,000 documented species of spider in the world. These species can be broken into two categories: web builders and ground dwellers. The type of web spider spins depends entirely on the spider's way of life. The pattern and architecture of webs varies family to family. During the study 6 types of web patterns Viz. Irregular webs, Sheet webs, Funnel webs, Orb webs, Single-line webs, Dome shaped horizontal webs were identified and analysed between July 2012 to June 2015. Study on the pattern and architecture of spider's web with special reference to seasonal abundance in the eastern region of Rajasthan, India (Lawania Kant Krishna and Mathur Priyanka 2015).

Conclusion

The study reported here describes the structure of spider webs and their identification in the Nagpur district. We provide an overview of different types of web forms found in this Nagpur area, as well as their structural and functional variability. The various spider web forms and their modifications described here closely represent the overall structure of spider webs.

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Conflicts of Interest Statement

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Author Contribution

Author Sonu G. Thawkar contributed to the methods and methodology, conducted the site visit, collected photographs, performed data analysis, and wrote the manu-

script. Author Sarayu V. Gonmode provided guidance, drafted the document, reviewed it, and approved the final manuscript.

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