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Studies on the properties of spider silk

Jeyaparvathi S., Manikandan K., Baskaran S., and Ga. Bakavathiappan

Post Graduate & Research Department of Zoology, Ayya Nadar Janaki Ammal College, Sivakasi - 626 124, Tamil Nadu, India.

ABSTRACT

Web weaving spiders depend upon the mechanical performance of capture threads. Many spiders depend upon webs to capture prey. Web function results from architecture and mechanical performance of the silk. We studied the properties of silken threads collected directly from field and laboratory condition to test for silk performance to different aspects of prey capture. We measured the length and width of four different types of webs like orb web, funnel web, dome web and irregular mesh web and we also measured the width of the single silken thread of the four spider webs. The mechanical properties of different type web threads were studied by measuring the width of the single thread using micrometry. The width of the prey capture thread was found to be higher in the orb web. The width of the egg sac thread was higher in the dome web and orb web. The length and width of different types of web were measured. The higher length of different types of web was found in orb web. We found that the orb webs were stiffer and stronger. These findings yield insight into the strength of the capture threads.

Key words: spider, web, silk, egg sac thread.

INTRODUCTION

Silk is used by spiders in dispersal in different ways. One method, bridging, is to cast a line into the breeze and, when it catches on a distant object, to climb out on the line to its end. Bridging may also be accomplished by dropping on a line and swinging on it to reach a new site [1]. Silk is a fibrous protein secreted by labial glands in Lepidoptera, Hymenoptera or by accessory tubes of the genital organs of hydrophilus, by tarsal glands of Embioptera and Embidae, and by malpighian tubes of certain blatella, a variety of insects and arachnids [2]. The native protein of silk gland "fibrinogen" is water soluble, while passing through the spinnerets it becomes a tough insoluble product "fibroin" in which the molecule assume an orderly crystalline arrangement in the long axis of the fiber. The silk, which is coated with sericin, a glue like proteins that hold the fibroin core together. The silk fibers have been used for decades as sutures in biomedical application and have potential as scaffolds in tissue engineering [6]. Spiders also actively modify the architectures of webs in response to predators and prey [7]. Thus, studying architectures of spider webs can give us insight into how spiders confront selective pressures in their environment. Some aspects of webs can be difficult to measure accurately in the field so that formulaic estimators are instead employed [8]. Spiders in the genus *Argiope* often decorate their nearly invisible orb webs with conspicuous zigzags of silk called stabilimenta. However, the ecological function of stabilimentum building is still unresolved [9]. Because of its reflectivity in both the visible and ultraviolet (UV) regions of the spectrum [12], many authors have suggested that the stabilimentum is used as a visual signal. However, it is much debated whether the primary recipients of this signal are predators, prey or mega fauna. Arguments that the primary recipients are predators suggest the stabilimentum thwarts predators by displacing attacks or changing the apparent size or shape of the spider [11].

MATERIALS AND METHODS

Collection of silk

Eighteen adult *Argiope anasuja* Thorell were collected from the cotton field located in Sriviiliputtur Taluk, Virudhunagar district, Tamilnadu, India as mature or penultimate females and housed individually in the laboratory in 20 cm x 20 cm cages. Silks were obtained from spiders within 3 weeks after capture, during which time spiders were fed a *Corcyra cephalonica* Staint. Ambient temperature in the laboratory ranged from 26–32°C and humidity varied from 60–70%. We collected major and minor ampullate silk from restrained spiders using forcible silking as previously described [2]. Capture spiral silk was harvested directly from the outermost spirals of freshly spun webs. Individual aciniform silk fibers were collected by first throwing *Artracto morpha crecnulata* (Fab.) into webs to induce prey wrapping attacks by spiders. We then inserted pieces of cardboard between the spiders and prey such that the spiders continued to wrap silk around the cardboard. After the spider had wrapped the cardboard with one or two layers of silk, the isolated individual fibers for testing by first gently pulling away adjacent fibers, taking care not to touch or pull upon the fiber of interest. We then adhered this single fiber to the same type of cardboard mount previously used to test other silk [10].

RESULTS AND DISCUSSION

During the present study four different types of webs have been observed. Three different families of spider have been observed namely Araneidae, Lycosidae and Eresidae, which has built different types of web. The higher percentage of different type of webs recorded in orb web (38%) followed by funnel web (25%), dome web (21%) and irregular web (16%) which is shown in Table 1**.**

MECHANICAL PROPERTIES

Width

The mechanical properties of different type web threads were measured by taking the width of the single thread using micrometry measured and showed in Table 2. The width of the prey capture thread was found to be higher in the orb web (24 µm ± 3.03) followed by dome web (14.22 µm ± 2.59), irregular web (11.94 µm ± 0.36) and funnel web (11.89 µm ± 0.62). The width of the egg sac thread was found to be higher in the dome web (14.92 µm ± 1.02) followed by orb web (14.04 µm ± 1.18), irregular web (12.75 µm ± 0.45) and funnel web (11.38 µm ± 0.39) shown in Table 3.

The width of the web thread was found to be higher in the orb web (35.83 µm ± 4.40) followed by dome web (30.02 µm ± 3.68), irregular web (28.97 µm ± 3.41) and funnel web (14.94 µm ± 2.47) shown in Table 4. The length and width of different types of web has been measured and showed in Table 5. The higher length of different types of web was found in orb web (39.90 ± 1.28) followed by funnel web (30.70 ± 2.18), dome web (29.50 ± 1.45) and irregular web (28.60 ± 1.41). The higher width of different types of web was found in funnel web (31.90 ± 0.76) followed by orb web (31.60 ± 1.98), irregular web (23.10 ± 1.09) and dome web (17.80 ± 0.69).

Table 1. Percentage of webs recorded in the study area during September, 2010 – February, 2011

S. No	Family	Types of web	Total no. of web (%)
1	Araneidae	Orb web	38
2	Araneidae	Dome web	21
3	Lycosidae	Funnel web	25
4	Eresidae	Irregular mesh web	16

Table 2. Mechanical properties of a single prey capture thread of webs

Types of web	Width of the Prey capture thread (µm)
Orb web	24 ± 3.03
Dome web	14.22 ± 2.59
Irregular web	11.94 ± 0.36
Funnel web	11.89 ± 0.62

Table 3. Mechanical properties of a single egg sac thread of spider webs

Types of web	Width of the Egg sac thread (µm)
Orb web	14.04 ± 1.18
Dome web	14.92 ± 1.02
Irregular web	12.75 ± 0.45
Funnel web	11.38 ± 0.39

Table 4. Width of a single thread of webs (in field condition)

Types of web	Width of the single thread (Habitat) (µm)
Orb web	35.83 ± 4.40
Dome web	30.02 ±3.68
Irregular web	28.97 ± 3.41
Funnel web	14.94 ± 2.47

Table 5. Length and width of different types of web

Types of web	Total length (cm)	Total width (cm)
Orb web	39.90 ± 1.28	31.60 ± 1.98
Dome web	29.50 ± 1.45	17.80 ± 0.69
Funnel web	30.70 ± 2.18	31.90 ± 0.76
Irregular web	28.60 ± 1.41	23.10 ± 1.09

DISCUSSION

Different types of spider webs include: Spiral orb webs, Funnel webs, Dome or tent webs, Irregular web. Some webs will have loose, irregular tangles of silk above them. These tangled obstacle courses serve to disorient and knock down flying insects, making them more vulnerable to being trapped on the web below. They may also help to protect the spider from predators such as birds and wasps [4]. During my present investigation, I have been recorded four types of web namely orb web, doom web, funnel web, irregular web. It shows the diversity of different types of web in an agro ecosystem. From the total number of webs observed the orb web (38%] occupies a dominant position in the occurrence in the field of agro ecosystem, because these orb webs has a potential of predatory character.

Our knowledge about molecular biology of spider silk and silk network structure is growing rapidly and provides a rational basis for the design of structural materials through genetic engineering. In the present work the mechanical properties of four different type of web's has been analysed to know their mechanical properties. From the analysis it shows that the orb web contains much width and elasticity when compared with other types of webs. Similar kind of work in mechanical properties was done by [3]. By analysing the mechanical property one can know its strength and how far one can use this spider web as a substitute for other synthetic silk fibres.

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REFERENCES

[1] Barth F, Komarek G S, Humphrey, J A C, Treidler B, **1991**, *J Comp Physiol*, **1991,** 169, 313-322.
[2] Blackledge T A, Swindeman J E, Hayashi C Y, *J Exp Biol*, **2005c,** 208, 1937-**1949**.
[3] Gosline J M, Guerette P A, Ortlepp C S, Savage, K N, *J Exp Biol*, **1999,** 202, 3295–303.
[4] Opell B D, *Evolutionary ecology research*, **1999**, 1, 503-516.
[5] Kaplan D L, Adams W, Farmer B, Viney C, *American Society Symposium Series*, **1994**, 544-555.
[6] Min B M, Jeong L Y, Nam S, Kim J M, Kim J Y, Park W H, *Int J Biol macromol*, **2004**, 34, 281-288.
[7] Blackledge T A, *Journal of Zoology*, **1998**, 246, 21–27.
[8] Venner S, Thevenard L, Pasquet A, Leborgne R, **2001**. *Annals of the Entomological Society of America*, **2001**, 94, 490–496.
[9] Herberstein M E, Craig C L, Coddington, J A, Elgar, M A, *Biological Reviews*, **2000a**, 75, 649–669.
[10] Hayashi C Y, Blackledge T A, Lewis R V, *Mol Biol Evol*, **2004**, 21, 1950-1959.
[11] Schoener T W, Spiller D A, *Behavioral Ecology and Sociobiology*, **1992**, 31, 309–318.
[12] Zschokke S, *Journal of Arachnology*, **2002**, 30, 246–254.