INTERNATIONAL JOURNAL OF HIGHER EDUCATION AND RESEARCH
IJHER, Vol., 8(2), 2018, 341-348.
www.ijher.com
IJHER
(ISSN 2277 260X)
CODEN:IJHER
ORIGINAL ARTICLE

COMPARATIVE STUDY OF CAPTURE AREA, WEB ASYMMETRY AND HUB ASYMMETRY OF WEB OF *Neoscona rumpfi* (Thorell) and *Leucauge decorata* (Blackwall) *FROM DARJEELING HIMALAYAS*

Priyankar Sanphui
Department of Zoology,
Sree Chaitanya College, Habra.
Prafullanagar, Habra, 24 parganas (N). Pin:743268, West Bengal, India
Corresponding author e-mail: psanphui@gmail.com

Abstract

Orb web Spiders are a group of spiders that constructs orb web for predation. The web is made of silk produced by the animal. The geometric architecture of the orb web and its connection with the foraging has always been a matter of interest. In the present study we compared the capture area, web asymmetry and hub asymmetry of the web of two species of orb web spider Neoscona rumpfi (Thorell) and Leucauge decorata (Blackwall). The study was carried out in Happy valley tea estate of Darjeeling. Our result clearly indicates that the capture area of the web of Neoscona rumpfi is significantly larger than Leucauge decorata. However the Web of Leucauge decorate is more asymmetric than that of Neoscona rumpfi. This is first study giving comparative account of web geometry and capture area of Neoscona rumpfi (Thorell) and Leucauge decorata (Blackwall) from this area.
Keywords: *Orb web, Capture area, Web asymmetry, Hub asymmetry.*

INTRODUCTION

Spiders are one of the preeminent silk craftsmen among arthropods and best known for production of aerial webs that can trap flying insects. Orb web spiders are ubiquitous predators in terrestrial ecosystems and are good model for behavioral and ecological research (Herberstein, 2011). The orb webs are composite structures made of different type of silk, each with unique molecular structure and mechanical function. There are more than 4500 species considered as orb web (Platnick, 2011).

Since orb web represents a behavioral and material investment in foraging by the orb web spider, web design is an important part of their foraging strategy (Blackledge, T.A., 1998). The foraging success depends largely on the prey capture efficiency of the web which is tightly related to its design. The webs of orb web spiders show great variation in their specific designs. Orb web designs may vary between species and also within species depending on food availability , age and body size of the spider. We have shown that in leg length is highly correlated with the capture area of the orb web in *Neoscona sp*. and *Leucauge sp.* from Darjeeling Himalayas (Sanphui et al 2017).

The capture area of an orb web determines the area of the web used for capturing the prey. The name 'orb' is somewhat misleading in that, the web are rarely fully symmetrical circles. They are instead elliptical in shape. Web asymmetry refers to the departure of the shape of the web from a circle. This index was used by Gregoric et al.(2010). The value of web asymmetry changes from zero to one or more indicates a web tends from symmetrical to asymmetrical. Negative value indicates horizontally exaggerated webs. The hub asymmetry of an orb web qualifies the displacement of the hub from web's geometric centre. The value of hub asymmetry is close to zero in symmetric webs, slightly above zero in upwardly eccentric webs

In the present study we compared the web geometry of *Neoscona rumpfi* (Thorell) and *Leucauge decorata* (Blackwall) from Darjeeling Himalayas.

MATERIALS AND METHODS

Study area:

The specimen used in the study was collected from the Happy Valley Tea Estate, Darjeeling, West Bengal, India. It is one of the oldest tea estate of the area. The total area of the garden is about 437 acre.

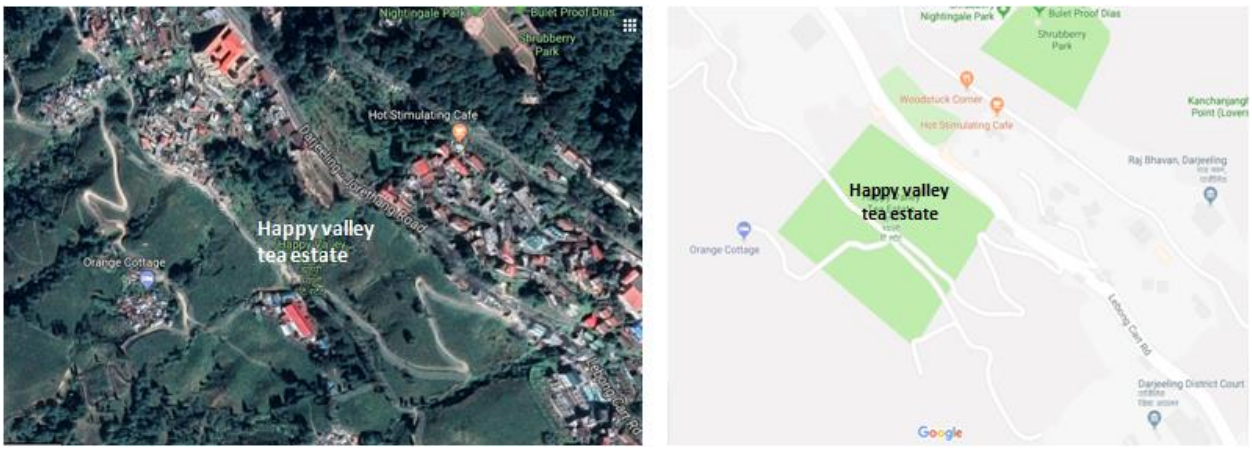


Figure 1: study site: Happy Valley tea estate (image from Google maps)

Species studied:

Neoscona rumpfi (Thorell): They belong to family Araneidae. They are typical orb weaving spiders. They are grayish brown in colour. They have oval abdomen and the legs have white striations. Sometimes they built nest like retreat by folding a leaf or bunch of leaves which are a little away from the web but directly connected with the web centre by threads.

Leucauge decorata (Blackwall): This species of spider belongs to family Tetragnathidae. They are long slim bodies with elongated abdomen which has metal shine look. They are commonly called as long-jawed orb weavers or long jawed spiders. The front legs are longer than any other leg. They are usually yellowish green in colour with silvery abdomen.

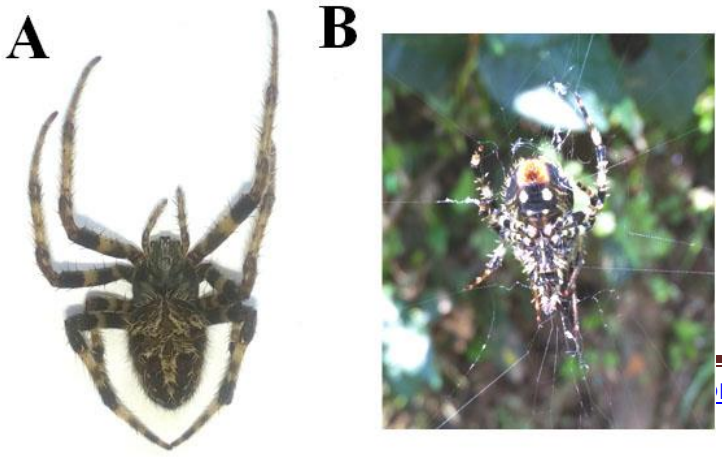


Figure 2: Neoscona rumpfi (Thorell). A: Dorsal view B. Ventral view

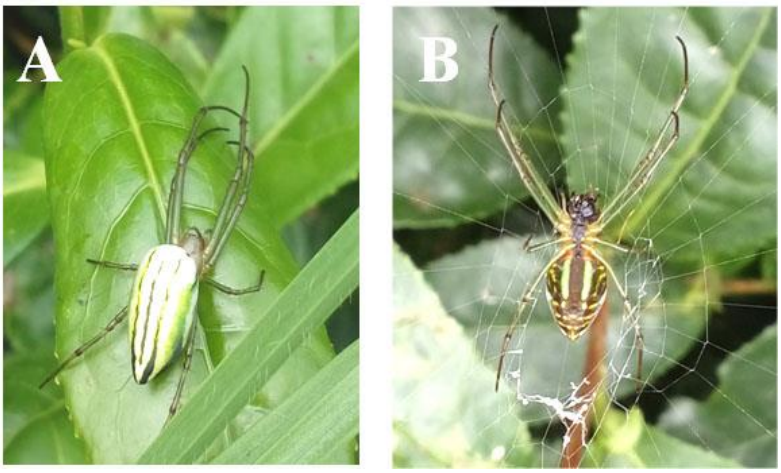


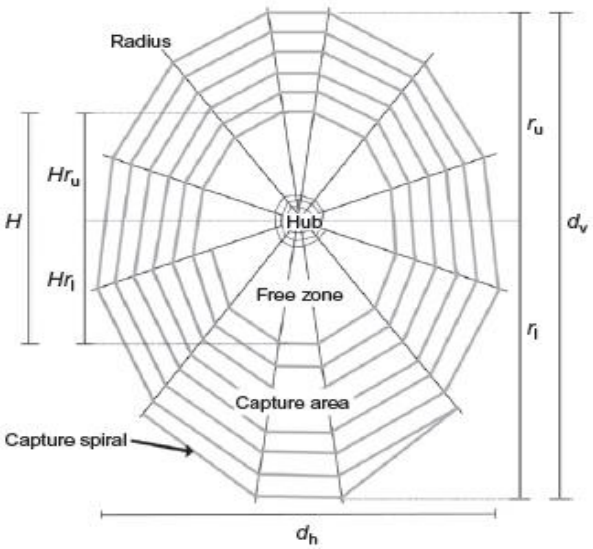
Figure 3: Leucauge decorata (Blackwall). A. Dorsal view B. Ventral view

Web characteristics and calculation of capture area, web asymmetry and hub asymmetry of web :

The webs of the adult spiders were only considered for study. Before recording the web data, each web was sprayed with flour to improve the resolution. The measurements of the web structure were done using slide calipers and scale and noted in the field note book. Capture areas were calculated following Herberstein and Tso (2000).

Capture area: $[\frac{1}{2}\pi r_{au}^2 - \frac{1}{2}\pi(Hr_u)^2] +$

* $r_{au} = (r_u + d_h/2)/2$ and $r_{al} = (r$



The formula used for web asymmetry was :

$$\text{web asymmetry} = 1 - \frac{d_h}{d_v},$$

And the formula used for hub asymmetry was:

$$\text{hub asymmetry} = 1 - \frac{r_u}{r_l}$$

Figure 4: Schematic diagram of orb web, showing different measuring parameter.
(after Herberstein and Tso (2000))

There is always a **free space or free zone** in between the non sticky portion or Hub & sticky portion of the web. During measurement, the measuring parameter used were :-$\mathbf{Hr_u}$- from the centre of the hub to the upper portion of the free zone; $\mathbf{Hr_l}$- from the centre of the hub to the lower portion of the free zone; $\mathbf{r_u}$- from the centre to the uppermost end of sticky fibre & $\mathbf{r_l}$ - from the centre to the lowermost end of sticky fibre; $\mathbf{d_h}$- it means simply width of the web, distance from outermost fibre of left side to the outermost fibre of right side across the centre of the hub.

Collection and identification of spider samples

Spiders were collected as described earlier (Sanphui et al. 2017). Briefly they were hand picking or picked by holding the tube close to the webs. The collected specimens were sacrificed and preserved in alcohol (70%) in separate tubes. The specimens were studied under Stereo Binocular Microscopes (Olympus SZX7) and identification was done following standard literatures. 25 specimen of *Neoscona rumpfi* (Thorell) and 28 specimen of *Leucauge decorata* (Blackwall) *Leucauge sp.* was considered for the present study

Statistical analysis

Students t test was performed to check the level of significance.

RESULTS:

Comparative account of capture area of *Neoscona rumpfi* and *Leucauge decorata*

We have shown that in both of these species the capture area is correlated with the leg length. Thus we selected the web of the spider having a leg length of 1.49 ± 0.4 cm in *Neoscona rumpfi* and 1.55 ± 0.2 cm *Leucauge decorata* Our result shows that the mean capture area of *Neoscona rumpfi* was 896 ± 96 sq cm. and that of *Leucauge decorata* was 426.34 ± 28 sq cm. The capture area of *Neoscona rumpfi* was significantly larger than that of *Leucauge decorata*

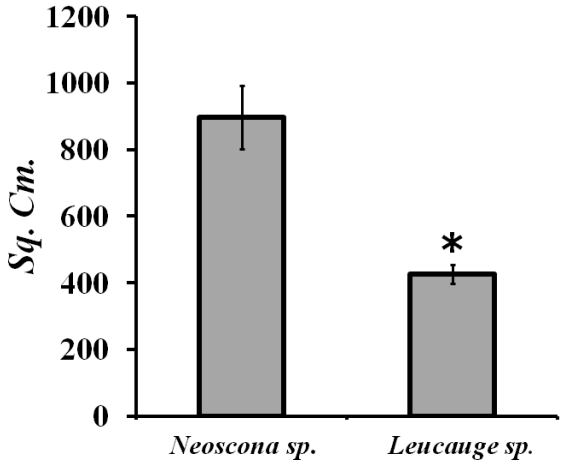
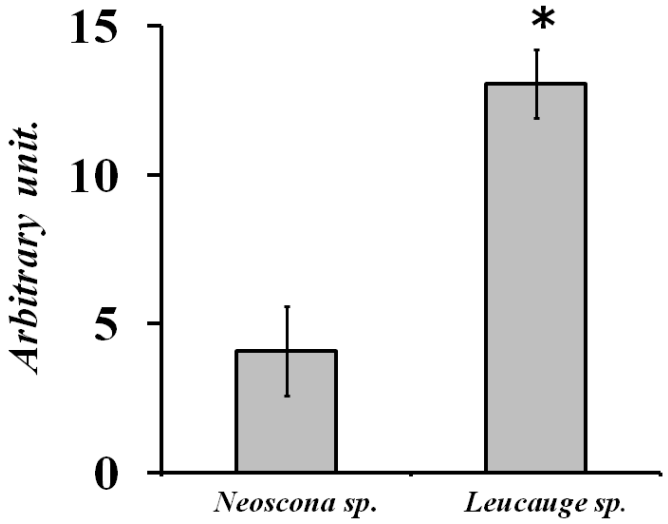


Figure 5 : Graphical representation of capture area of Neoscona rumpfi and Leucauge decorate. Data shown as mean ±SEM of 25 and 28 webs respectively. Asterisks indicate statistical significant difference between two groups. *p<0.05

Comparative account of web asymmetry of *Neoscona rumpfi* and *Leucauge decorata*

The web asymmetry was calculated following the formula given earlier. Our results shows the mean web asymmetry was 4.08 ± 1.5 in *Neoscona rumpfi* and 13.05 ±



1.15 *Leucauge sp.* The result clearly indicates that the webs of *Leucauge decorata* are more asymmetrical compared to those of *Neoscona rumpfi*. The value of web asymmetry of *Leucauge decorata* also indicate that the webs are strongly vertically elongated.

Figure 6 : Graphical representation of web asymmetry of Neoscona rumpfi and Leucauge decorate. Data shown as mean ±SEM of 25 and 28 webs respectively. Asterisks indicate statistical significant difference between two groups. *p<0.05

Comparative account of hub asymmetry of *Neoscona rumpfi* and *Leucauge decorata*

The hub asymmetry was estimated to be 0.27 ± 0.03 in *Neoscona rumpfi* and 0.216 ± 0.043 in *Leucauge decorata* . there was no significant difference between the hub asymmetry of the two species studied. Our result also indicates that both the webs are upwardly eccentric web.

DISCUSSION:

In the present study capture area, web asymmetry and hub asymmetry of 25 adult specimen of *Neoscona rumpfi* and 28 adult specimen of *Leucauge decorate* was considered. The body dimension of the spiders was almost similar.

Nature of the studied webs was asymmetrical and vertically elongated particularly in the lower half. Capture threads appear to play a critical role in the operation of the web as it forms the mesh intercept and retains insects (Opell 1999). the leg length was found tobe correlated to the capture area in these species of spiders (Sanphui et al 2017). So we selected spider of same average size for our study. The webs of *Neoscona rumpfi* was found to have significantly greater capture area than that of *Leucauge decorate* of similar size. This implies that the capture efficiency of adult *Neoscona rumpfi* is more than that of *Leucauge decorate.*

To study the web asymmetry only the vertical webs were taken into consideration. For both the species the webs were found to be asymmetrical. However the webs of *Leucauge decorate* were significantly more asymmetrical than that of *Neoscona rumpfi.*

In case of the hub asymmetry we could not detect any significant difference between the webs of *Neoscona rumpfi* and *Leucauge decorate.*

A large web increases the rate of prey interception and the distance between the capture spirals affects the visibility of the web and the size of prey entangled (Herberstein & Tso,2000). The orb

web's ability to capture insects is enhanced by both capture area and increased stickiness. Thus greater the capture area implies greater foraging success. The success of areal snares constructed by these spiders depends on the availability of insect and the webs ability to intercept those. Interception is influenced by web area, its orientation, its invisibility to the insect and by visibility of the spider positioned at web hub.

ACKNOWLEDGEMENTS:

The author express sincere thanks to The Principals, Sree chaitanya College, Habra for necessary logistic support and encouragement. The author will also like to thank Dr. Sumana Saha for her encouragement and support. Sincere thanks are also due to Dipsmita Mukherjee and Subhabrata Dey for their help during the study.

REFERENCES

Blackledge, T.A., 1998. Stabilimentum variation and foraging success in *Argiope aurantia* and *Argiope trifasciata* (Araneae: Araneidae). Journal of Zoology, 246: 21-27.

Gregoricˇ, M., Agnarsson, I., Blackledge, T. A. and Kuntner, M. (2011). Darwin's bark spider: Giant prey in giant orb webs (Caerostris darwini, Araneae: Araneidae)? J. Arachnol. 39, 294–302

Herberstein M E and Tso I M. 2000: evaluation of formulae to estimate the capture area and mesh height of orb webs (araneoidea, araneae). J . Arachnol 28:180-184

Herberstein, M. E. and Tso, I. M. (2011). Spider webs: evolution, diversity and plasticity. In: Spider Behavior: Flexibility and Versatility (ed Herberstein, M. E.), pp. 57–98. Cambridge University Press, New York.

Opell, B.D., 1998: Economics of spider orb-webs: the benefits of producing adhesive capture thread and of recycling silk. Funct. Ecol., *12*, p. 613-624.

Platnick, N. I. (2011). The World Spider Catalog, Version 11.5. Online at http://research.

amnh.org/iz/spiders/catalog (American Museum of Natural History)

Priyankar Sanphui , Subhabrata Dey , Dipsmita Mukherjee & Sumana Saha. 2017. Affirming length of body or part/s and weight there of as a determinant of capture area of spider web. World scientific news,71: 128-137