International Journal of Life Sciences
International Peer Reviewed Open Access Journal

Special Issue | A20 | April 2023
ISSN:2320-7817(p) 2320-964X(0)

Original Article Open Access

Web architecture of giant orb weaver, *Nephila pilipes* in response to habitat and food

Sawarkar AS

Department of Zoology, Shri R. L. T. College of Science, Akola, M.S., India
E-mail: assawarkar@yahoo.com

Manuscript details:

Available online on http://www.ijlsci.in
ISSN: 2320-964X (Online)
ISSN: 2320-7817 (Print)

Cite this article as:
Sawarkar AS (2023) Web architecture of giant orb weaver, *Nephila pilipes* in response to habitat and food, *Int. J. of. Life Sciences*, Special Issue – A 20 : 13-16.

Article published in Special Issue on "*National conference on Advances in Biodiversity Conservation and Sustainable development: Educational & Scientific Research Perspective NCABCSD-2023*" organised by Department of Life Sciences, Shri Shivaji Science College, Amravati (MS) India - 444 603 Dated March 3 - 4, 2023.

ABSTRACT

The web of *Nephila pilipes* is usually seen among the tall trees in the forest. Female golden orb web spider, *Nephila* uses her web as semi-permanent home site. Some web architectural parameters were measured in 15 webs of subadult and adult female *Nephila* spiders in deep forest and sparse forest each. In deep and dense forest, overall web size is larger than in sparse forest. Web width and web height is comparatively more in dense forest. In sparce forest, web shows more hub displacement and less mesh width to enhance prey capture efficiency. Whereas in dense forest webs, there is less hub displacement and wide mesh width to capture larger prey. Large population of healthy *Nephila* with larger and more symmetrical webs is seen in dense forest. Giant wood spider, *Nephila* is at the top of food web of small invertebrates. This food web is the subset of food web of top carnivore like tiger. Hence, for healthy forest ecosystem, these spiders should conserve by protecting their natural habitat.

Keywords: Nephila, web architecture, hub displacement, mesh width.

INTRODUCTION

The forest of Melghat is dry deciduous, dominated by *Tectona grandis.* In this forest, the golden orb web spider *Nephila pilipes* is found in abundance. Female spider is conspicuous due to its large size and banana like yellow stripes against dense background color of the body. The fundamental unit of behaviour in the orb web spiders is the construction and design of the web (Herberstein, 2000). Silk production and web construction are energetically costly (Miyashita, 1986). Selection of site for web construction is critically important aspect of the foraging strategies. Orb weaving spiders are traditionally referred to as sit and wait predator that typically invest only a little of their energy after the orb web has been constructed (Uetz *et al.* 1992). Therefore, before building a web the spider has to take very important decision where to construct a web, which affects its future foraging success (Prakop, 2005). Nearly rectangular, uniform and narrow mesh width in capture area of *Nephila pilipes* web seems to be more efficient at intercepting prey. Sticky spirals of tight mesh adhere to insects, thereby preventing insects from escaping web before they are captured by spiders. A slight variation in the geometry markedly affects the prey-capture ability of spider orb webs (Soler and Zaera, 2016).

MATERIALS AND METHOD

Web features of orb web of *Nephila pilipes* were studied in natural habitat of woods of Melghat, Maharastra (21°26′45″N 77°11′50″E21.44583°N 77.19722°E). Web architectures of spiders were recorded in the field by using a FUJIFILM FINEPIX 52000HD 10.0 MEGA PIXELS 15X wide digital camera. In order to increase visual contrast, webs were dusted with cornstarch. Randomly encountered sample of 15 webs of *Nephila pilipes* each from deep forest area of Gullarghat and sparse forest area near Popatkhed were observed, studied and measured in the months of November. Following parameters were measured on every web: 1. Web width (a) as the horizontal distance between the outermost sticky spirals; 2. Web height (b) as the vertical distance between the top and lowest sticky spirals; 3. Top sticky spirals to hub distance (c); Number of sticky spirals per 10 cms in the finished webs. All measurements were reported in centimeters. Web architecture parameter like hub displacement (HD = (b-c)/b) was calculated as used by Kuntner *et al.* (2008). Mesh width or mesh height is the distance between two sticky spirals (SS). It was calculated by formula: $\text{Mesh Height} = \frac{\text{distance}}{(SS-1)}$ (Gregoric *et al.*, 2010).

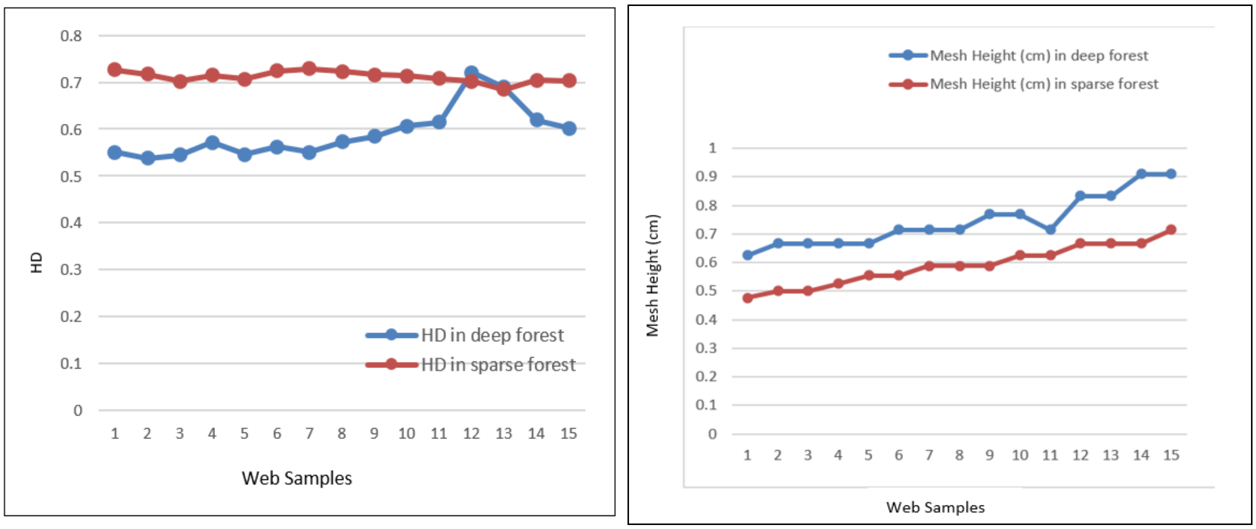
RESULTS AND DISCUSSION

Adult female *Nephila pilipes* built a huge web between tall trees. The main structural elements of an orb web of *Nephila pilipes* are the bridge lines, which anchors to the substrate; the frame thread, which connect directly to the substrate or to other lines in the web; the radii connect the frames with the central hub and the sticky or capture spiral is a continuous thread which attached to the radii as it spirals from the periphery to the hub (Figure-1:a and b).

During the present study, in all web measurements, the hub displacement (HD) value was more than 0.5. As we go from deep and dense forest to sparse forest, this measure of web allometry i.e. hub displacement (HD) increased. In deep forest, it ranged between 0.55 to 0.60 and in sparce forest, it reaches up to 0.729 (Figure- 2a). More symmetrical orb webs of *Nephila* are seen in deep forest. Mesh height measured in deep forest was ranged between 0.625 to 0.909 cm and in sparse forest, it ranged between 0.476 to 0.714 (Figure- 2b).

a b

Figure-1: a. Orb web of adult female *Nephila pilipes* in deep forest; **b.** Orb web of adult female *Nephila pilipes* in sparse forest



a b

Figure-2: a. Comparison of hub displacement (HD) of *Nephila pilipes* webs built in deep forest and sparse forest habitats; **b.** Comparison of mesh height of *Nephila pilipes* webs built in deep forest and sparse forest habitats.

The web is the sole weapon for capturing the prey. In sparse forest, web shows more hub displacement and less mesh width to enhance prey capture efficiency. The quality of a foraging site can have a significant effect on the survival, growth and reproductive success of web building spider (Lubin *et al*., 1993). Larger asymmetrical orb webs might be interpreted as increased foraging effort. A tight and nearly uniform mesh provides more silk per unit area for kinetic energy absorption as well as more stickiness per unit area and may well result in more effective snare for relatively larger prey (Sawarkar and Sawarkar, 2019). Successful captures occurred more frequently in the web sector below the spider. This was not surprising as the lower half of the web is more profitable foraging area because gravity helps the spider to reach the prey faster below the hub and spiders generally position their head downwards when waiting for prey. The detected ontogenetic pattern of progressive vertical web asymmetry in *Nephila* may be explained by optimal foraging due to gravity because spider's downward running speed is greater compared with upward speed (Nakata and Zschokke, 2010). Thus, by increasing the lower and decreasing the upper half of the web i.e. hub displacement, spiders may increase the chance that prey will be intercepted and captured successfully. Trapped prey struggling to escape generally tumble down the web. The longer vertical diameter may retain tumbling prey for a longer period of time, and this may be a reason for building more vertically elliptic orb-webs in sparse forest, where prey availability is lesser than dense green forest. The elliptic may cause the spider to reduce the amount of attention given to its flanks, owing to the relatively low prey interception frequencies in the relatively small horizontal sectors. Alternatively, a higher rate of prey detection failures in horizontal sectors of the web might cause spiders to reduce the investment of silk in the horizontal sectors, resulting in vertically elliptic webs (Nakata, 2010).

CONCLUSION

Orb web architectural flexibility including hub displacement and mesh height might be a complex response involving the spiders foraging needs. Increased hub displacement and decreased mesh height in webs of sparse forest helps to catch smaller and more insects which retain long enough to be captured by spider. Increased mesh height in deep and dense forest webs helps to capture larger prey, thus providing these spiders more profitable nutrition. Giant wood spider, *Nephila* is a bioindicator of healthy forest ecosystem. Hence, should conserve by protecting their natural habitat.

Conflicts of interest: The authors stated that no conflicts of interest.

REFERENCES

Gregorič M, Kostanjšek R and Kuntner M (2010) Orb web features as taxonomic characters in *Zygiella. s. l.* (Araneae: Araneidae). *J. Arachnol*., 38: 319-327.

Herberstein ME (2000) Evaluation of formulae to estimate the capture area and mesh height of orb webs (Araneoida, araneae). *J. Arachnol*., 28: 180-184.

Kuntner M, Haddad CR, Aljančič G and Blejec A (2008) Ecology and web allometry of *Clitaetra irenae*, an arboricolous African orb-weaving spider (Araneae, Araneoidea, Nephilidae). *J. Arachnol.,* 36: 583-594.

Lubin Y, Ellner S and Katzman M (1993) Web relocation and habitat selection in a desert widow spider. *Ecol*., 74: 1915-1928.

Miyashita T (1986) Growth, egg production and population density of the, spider, *Nephila clavata* in relation to food conditions in the field. *Res. Popul. Ecol*. 28: 135-149.

Nakata K (2010) Attention focusing in a sit-and- wait forager: a spider controls its pray-detection ability in different web sectors by adjusting thread tension. *Proc. R. Soc. B,* 277: 29-33.

Nakata K and Zschokke S (2010) Upside-down spiders build upside-down orb webs: web asymmetry, spider orientation and running speed in *Cyclosa. Proc. R. Soc. B* 277: 3019–3025 doi:10.1098/ rspb.2010.0729.

Prokop P (2005) Web inclination alters foraging success of a nocturnal predator. *Ital. J. Zoo.*, 72 (3): 249-252.

Sawarkar AS and Sawarkar SB (2019) Orb web features of giant wood spider *Nephila pilipes*. *Research Journey,* Spl 110(G):145-149.

Soler A, Zaera R (2016) The secondary frame in spider orb webs: the detail that makes the difference. *Sci Rep* 6: 31265. https://doi.org/10.1038/srep31265

Uetz GW, Bischoff J and Raver J (1992) Survivorship of wolf spiders (Lycosidae) reared on different diets. *J. Arachnol*., 20: 207-211.

2023 | Published by IJLSCI