



Scholars Research Library

Annals of Biological Research, 2013, 4 (11):55-59  
(<http://scholarsresearchlibrary.com/archive.html>)



## Describing stabilimentum-building and other web characteristics in selected fed and unfed *Argiope* spiders

<sup>1</sup>Liza A. Abrenica-Adamat, <sup>1</sup>Mark Anthony J. Torres, <sup>2</sup>Jessie G. Gorospe,  
<sup>1</sup>Ruben L. Amparado Jr. and <sup>1</sup>Cesar G. Demayo

<sup>1</sup>Department of Biological Sciences, College of Science and Mathematics, MSU-Iligan Institute of Technology, Iligan City

<sup>2</sup>Mindanao State University-Naawan, Naawan, Misamis Oriental

### ABSTRACT

This study describes stabilimentum-building and other web characteristics in selected fed and unfed *Argiope* spiders – *A. luzona*, *A. catenulata*, *A. appensa* and *A. aemula*. Fed *A. luzona*, *A. appensa*, and *A. aemula* built longer stabilimenta. However, the stabilimentum length did not differ between fed and unfed *A. catenulata*. Unfed *A. luzona*, *A. catenulata*, *A. appensa* and *A. aemula* also built webs with larger web area and intake area. The web mesh height built by unfed spiders did not differ significantly with fed spiders in *A. luzona*, *A. catenulata*, and *A. aemula*. However, unfed *A. appensa* built webs with shorter mesh height. These results indicate that *Argiope* spiders do not alter size of stabilimenta in response to prey-intake alone, and factors other than prey intake are involved.

**Key words:** *Argiope*, stabilimenta, spider webs, prey, UTHSCSA Image Tool

### INTRODUCTION

Foraging, the act of searching for and exploiting food resources is essential for animal's growth, reproduction and survival [1]. In times of depletion of resources, animals having foraging innovation abilities will likely survive [2]. For the orb spiders, the web is the principal foraging tool with an architectural design known to be evolutionarily unstable [3]. It is considered an extended plastic phenotype responding to variations in prey utilization parameters [4]. Since orb spiders are stationary predators, the ability to intercept prey or attract prey is particularly important especially for resources that are patchy in distributions in space and time [5]. For example, the length of silk and web size including the stabilimentum (plural= 'stabilimenta'), a conspicuous, white zigzag silk decoration added onto the central portion of the web were argued to be most important in foraging [6][7]. Foraging studies however, show contradicting information on stabilimentum-building and other web characteristics of orb spiders with prey intake. It was hypothesized that the spiders build larger webs in response to higher prey intake [8] or the large web size reflects spiders' increased foraging effort following previous low foraging or low prey-intake success [9][10][11]. We reinvestigate these hypothesis by examining how stabilimentum-building and other web characteristics respond to variation in food intake in four *Argiope* species (Araneae, Araneidae, Argiopinae), namely: *A. luzona*, *A. catenulata*, and *A. appensa* and *A. aemula*.

### MATERIALS AND METHODS

#### Feeding Treatment

A total of eighty (80) female spiders –fifteen (15) each of *A. luzona* and *A. aemula*, 20 *A. catenulata*, and 30 *A. appensa* were evaluated. Only adult female spiders (Figure 1) were included in the experiment, because mature male spiders do not build large webs with foraging functions. Each spider was housed in a 60x60x10 cm wooden cage

with the front and back area covered with clear plastic sheets and all other sides covered with screen to provide ventilation. Spiders that built functional webs were given one grasshopper for three days prior to observation. To quantify the effect of feeding on stabilimentum-building and other foraging-associated web characteristics (Figure 2), prey intake was manipulated. For at least three days, *A. appensa* and *A. catenulata* were given one large grasshopper (Body length: 1.2-1.6 cm; weight:  $0.1509 \pm 0.071$ g). The spiders were then deprived of prey for 7 days. For unfed spiders, only webs on the 4<sup>th</sup> to the 7<sup>th</sup> day were included in the analysis. For *A. luzona* and *A. aemula*, the whole procedure was repeated but the mealworm *T. molitor* larvae (Body length: 1.5-1.7 cm; weight:  $0.1517 \pm 0.03$ g), was used as prey. Mealworms were used as prey for *A. luzona* and *A. aemula* due to unavailability of grasshoppers during the conduct of the study. Only new-built webs were included in the analysis. Some web radii were also cut to encourage web-rebuilding. Water was provided to spiders through spraying the web.

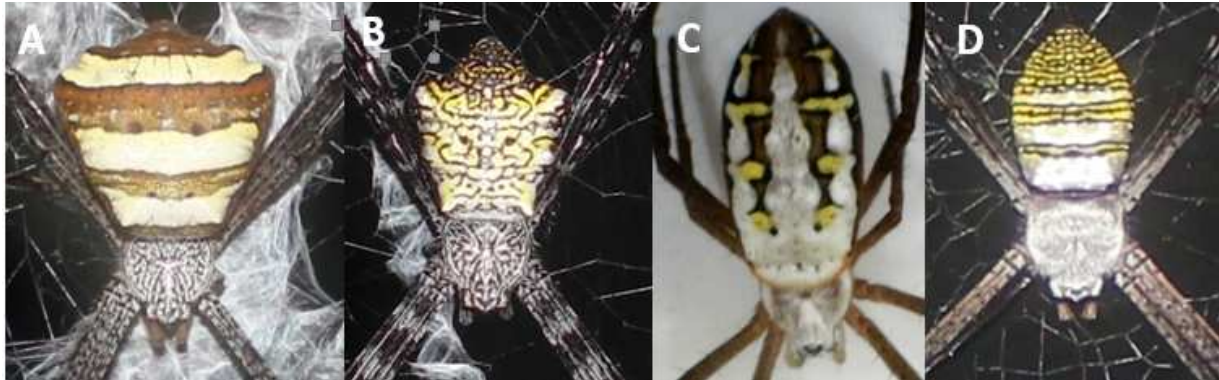


Figure1. The Four *Argiope* species. (A) *A. luzona*. (B) *A. appensa*. (C) *A. catenulata*. (D) *A. aemula*

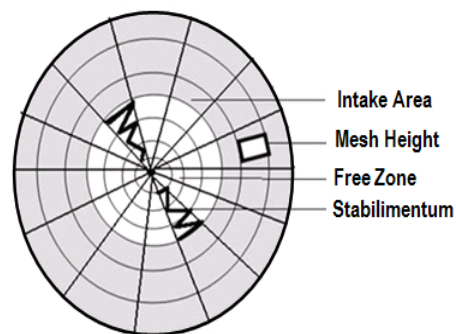


Figure 2. A schematic web of *Argiope* spp. demonstrating the web parameters measured. Free zone (white-color) is the area in the center of a web covered by non-sticky spirals and is present in both decorated and undecorated webs. Intake area (gray-color) is the rest of web area covered by sticky spirals. Mesh height is the distance between two consecutive sticky spirals

### Measurements

Webs were sprayed with water before measurement in order to render them visible. The web was photographed with a ruler for calibration and imported to UTHSCSA *Image Tool* ver. 3 software [12] for the necessary measurements. The web intake area was computed by subtracting the free zone from the web area and the stabilimentum length was measured as the total length of all arms.

### Statistical Analyses

One-Way ANOVA Test was used to compare between feeding treatments in terms of stabilimentum-building frequency and length, web size, intake area, and mesh height using the PAST (Paleontological Statistics) Software version 2.17c [13].

## RESULTS

Feeding increased the stabilimentum-building frequency in *A. appensa* (unfed: 28% vs. fed: 58%;  $p < 0.05$ ) insignificant in *A. catenulata* (fed: 43%, vs. unfed: 50%; ANOVA:  $F=0.085$ ;  $df=1$ ;  $p=0.77$ ), relatively similar between *A. luzona* (fed: 100%; unfed: 100%) and *A. aemula* (fed: 100%; unfed: 100%) suggesting that only *A. appensa* alter the stabilimentum-building frequency in response to variation in prey intake.

Food-deprivation decreased the stabilimentum length in webs of *A. luzona*, *A. appensa* and *A. aemula* while no effect was observed on stabilimentum length in *A. catenulata* (Table 1). All four species produced webs with significantly larger size when unfed (Table 2) and produced webs with significantly larger intake area when unfed (Table 3).

Consistently, the mesh height did not differ in spiders in the presence of prey and in the absence of prey in webs of *A. catenulata*, *A. luzona* and in *A. aemula* (Table 4). This result suggests that in the absence of prey, these spiders built larger webs with larger mesh height, mainly directed in increasing the number of prey caught, and the likelihood of catching large prey. However, unfed *A. appensa* respond to food-deprivation by building webs with narrower mesh height.

**Table 1. Summary on Mean ( $\pm$ SD) stabilimentum length (cm) for fed and unfed spiders**

Spider	Fed	Unfed	P*
<i>A. luzona</i>	21.56 $\pm$ 5.80; N=52	17.66 $\pm$ 6.97; N= 81	0.0020
<i>A. catenulata</i>	2.68 $\pm$ 1.38; N=63	3.18 $\pm$ 1.66;N=50	0.9105
<i>A. appensa</i>	10.05 $\pm$ 5.12; N=58	7.91 $\pm$ 2.90; N=40	0.0211
<i>A. aemula</i>	16.23 $\pm$ 3.93; N=31	9.33 $\pm$ 4.82; N=31	0.0001

\*One-way ANOVA test

**Table 2. Summary on Mean ( $\pm$ SD) web area (cm<sup>2</sup>) for fed and unfed spiders**

Spider	Fed	Unfed	P*
<i>A. luzona</i>	1080.9 $\pm$ 465.7; N=38	1571.15 $\pm$ 416.7; N=79	<0.0001
<i>A. catenulata</i>	900.52 $\pm$ 441.5; N=30	1675.84 $\pm$ 423.9; N=42	0.0005
<i>A. appensa</i>	1249.8 $\pm$ 468.0 ; N=60	2079.7 $\pm$ 461.1; N=60	<0.0001
<i>A. aemula</i>	856.5 $\pm$ 404.9; N=31	1565.6 $\pm$ 421.7; N=31	<0.0001

\*One-way ANOVA test

**Table 3. Summary on Mean ( $\pm$ SD) web intake area (cm<sup>2</sup>) for fed and unfed spiders**

Spider	Fed	Unfed	P*
<i>A. luzona</i>	1041.2 $\pm$ 464.5;N=36	1527.48 $\pm$ 355.8; N=68	<0.0001
<i>A. catenulata</i>	802.64 $\pm$ 434.63;N=30	1602.67 $\pm$ 418.47;N=42	0.0009
<i>A. appensa</i>	1168.4 $\pm$ 494.1; N=50	2017.2 $\pm$ 405.4;N=50	<0.0001
<i>A. aemula</i>	816.86 $\pm$ 399.9;N=31	1465.9 $\pm$ 414.2;N=31	<0.0001

\*One-way ANOVA test

**Table 4. Summary on Mean ( $\pm$ SD) web mesh height (cm<sup>2</sup>) for fed and unfed spiders**

Spider	Fed	Unfed	P*
<i>A. luzona</i>	0.46 $\pm$ 0.8; N=36	0.45 $\pm$ 0.10;N=68	0.6162
<i>A. catenulata</i>	0.36 $\pm$ 0.07;N=52	0.38 $\pm$ 0.07;N=42	0.3470
<i>A. appensa</i>	0.49 $\pm$ 0.09; N=50	0.43 $\pm$ 0.06;N=50	0.0007
<i>A. aemula</i>	0.48 $\pm$ 0.06;N=31	0.49 $\pm$ 0.7;N=31	0.5164

\*One-way ANOVA test

## DISCUSSIONS AND CONCLUSION

The results have shown that prey-deprivation had no effect on stabilimentum-building frequency in webs of *A. luzona*, and *A. aemula*. However, these spiders built webs with larger size, larger intake area, and shorter stabilimenta when unfed while no significant change in mesh heights was observed in webs of fed and unfed spiders. It was also observed from the results that prey-deprivation had no effect on stabilimentum-building frequency and stabilimentum length in *A. catenulata*. As also observed among *A. luzona* and *A. aemula*, unfed *A. catenulata* spiders built webs with larger size and larger intake area. Likewise, no significant change in mesh heights was also observed in spiders in the presence of prey and in the absence of prey in webs of *A. catenulata*.

The results have also shown that only *A. appensa* alter the stabilimentum-building frequency in response to variation in prey intake. Unfed *A. appensa* spiders also built webs with larger size, larger intake area, and shorter stabilimenta. However, among the four species, only *A. appensa* spiders built webs with significantly shorter mesh height in the absence of prey since the mesh height in webs of *A. catenulata*, *A. luzona* and in *A. aemula* spiders did not differ in spiders in the presence of prey and in the absence of prey. Although, *A. appensa* spiders produced shorter mesh height when unfed, however [14] reported that *A. appensa* spiders fed with large-sized prey (grasshopper: Body length=1.2-1.4 cm) spun webs with larger mesh height than when fed with small-sized prey (*Drosophila sp.*: Body length=0.25-0.30cm) (Small Prey=0.3537 $\pm$ 0.0824 cm vs. Large Prey=0.4837 $\pm$ 0.0896cm; p<0.001). Hence, it can be argued that all four *Argiope* spiders- *A. luzona*, *A. catenulata*, *A. appensa* and *A. aemula* respond to a reduced rate of feeding or reduced intake success by building webs optimized for intercepting larger prey. In other words, spiders

experiencing high risk of starvation or low intake success tended to be less generalist, aiming primarily larger prey. It has been argued that large prey items play a crucial role in spiders reaching adulthood and in maximizing fecundity of female orb-web spiders [15]. But it should also be noted that the common prediction that larger mesh widths target larger prey is not necessarily supported [16][17][18]. In particular, [18] reported that webs with denser intake meshes perform better at capturing large prey.

The observed differential effect of prey intake among *A. luzona*, *A. catenulata*, *A. appensa* and *A. aemula* orb silk (web area and intake area) and stabilimentum silk between fed and unfed spiders may have resulted from a difference in utilization and activity of glands producing these silks [19]. Aggregate and flagelliform silk glands produce orb silk [20][21] while aciniform glands produce aciniform silk which is use for both prey-wrapping and stabilimentum-building [22][23][24].

Previous studies have suggested that spiders use accumulated excess silk for stabilimentum due to a constant secretion in the aciniform glands [22]. However, [24] reported that aciniform silk removal due to stabilimentum-building and prey-wrapping may stimulate gland activation which is an important mechanism to ensure highly efficient wrap attack strategy of *Argiope* spiders especially under high prey density and repeated wrapping events. As observed, fed spiders used aciniform silk to subdue, to immobilize and to wrap the intercepted prey. Fed *A. luzona*, *A. appensa* and *A. aemula* spiders tended to produce longer stabilimenta. Prey-wrapping and stabilimentum-building activities among fed *A. luzona*, *A. appensa* and *A. aemula* spiders might consequently reduce the aciniform silk reserves and might have resulted to longer and thicker stabilimenta, which would be expected considering that catching (subduing and immobilizing) larger prey such as grasshopper or *T. molitor* larvae requires much silk during wrap attack. Perhaps *Argiope* spiders always decorate their webs whenever possible but the amount of silk available in the aciniform gland determines the length of stabilimenta [24]. This could explain why fed spiders tended to build longer stabilimenta in *A. luzona*, *A. appensa* and *A. aemula*. Consistently, since unfed spiders did not use their wrapping silk and thus did not deplete their aciniform gland, a reduced stabilimentum length was a reasonable consequence.

Although the differential prey-intake between fed and unfed spiders in this study affected web characteristics such as web area, intake area and mesh height in all species observed, however, it did not affect the length of stabilimenta in *A. catenulata* as predicted. This result is unsurprising considering that most of *A. catenulata* individuals (>50%) used in the experiment were gravid as indicated by the presence of egg sacs on the periphery of their webs. It has been suggested that gravid spiders may reduce their prey intake, and thus have less need for consistently high gland activity to facilitate spontaneous wrap attacks [25]. These results show that, although stabilimenta is considered one of *Argiope* spiders' foraging efforts, the control of its spinning is far more complicated than of other web foraging related characteristics examined here, suggesting that prey-intake is not the sole controlling factor [26].

Current data have also shown that prey intake caused an increase in stabilimentum-building activity or stabilimentum length combined with significant decrease in web size and intake area, suggesting a tradeoff between both parameters, which might reflect different foraging strategies. A similar finding was observed by [27] in *Argiope appensa*, suggesting that large webs without stabilimenta yield a similar intake success as small webs with "prey-luring decorations". As reported by [9][28][10] many araneoid spiders tend to construct larger webs or increase the intake area of their orb-webs during times of low prey-intake, an adaptive strategy of an increased foraging effort by spiders experiencing reduced prey-intake.

Furthermore, according to the prey-attraction hypothesis stabilimenta are used to attract prey [29][30][21][31][32][14]. Considering that stabilimenta is energetically inexpensive, stabilimentum is expected to be more common and longer in webs built by spiders with low foraging success [6]. On the contrary, our results failed to support the prey-attraction hypothesis, since unfed *A. luzona*, *A. appensa* and *A. aemula* spiders invest less on stabilimentum-building. We did not directly test the prediction of prey attraction. However, it has been argued that if stabilimenta function to lure prey, then spiders experiencing poor intake success should invest more in stabilimentum-building [6].

The present results have suggested that unfed spiders may respond to the reduced rate of feeding by building webs optimized for intercepting more prey or larger prey. In building larger web area, larger intake area, and longer mesh heights, spiders would increase the chance and frequency of foraging [8], thereby increasing the likelihood of catching more prey or larger prey. Our results regarding the effects of prey availability on web area, intake area and mesh heights confirmed with previous findings of increased foraging activity and it support the view that orb-web is highly plastic and adapts to current foraging requirements [33][10].



**Acknowledgments**

We thank the Department of Biological Sciences and the MSU-IIT administration for the partial Faculty Development Program support and to those whose names are too numerous to mention for the extended support in the conduct of this study.

**REFERENCES**

- [1] E Danchin; L Giraldeau; F Cezilly. *Behavioural Ecology*. New York: Oxford University Press, **2008**; pp.300
- [2] LA Dugatkin . *Principles of Animal Behavior*; **2004**.
- [3] TA Blackledge; N Scharff; JA Coddington; T Szuts; JW Wenzel; CY Hayashi; I Agnarsson. *Proceedings of the National Academy of Science. USA*, **2009**, 106, 5229-5234.
- [4] SJ Blamires. *Journal of Experimental Biology*, **2010**, 213, 3207-3212.
- [5] CL Craig; RS Weber GDBernard. *American Naturalist*, **1995**, 147, 205–229.
- [6] TA Blackledge. *Journal of Zoology*, **1998**, 246, 21-27.
- [7] TA Blackledge; J Wenzel. *Behavioral Ecology*. **1999**.10, 372-376.
- [8] GW Uetz; SP Hartssock. *Psyche (Cambridge)*, **1997**, 94, 103-116.
- [9] LE Higgins; RE Buskirk. *Animal Behavior*, **1992**, 44, 485-499.
- [10] PM Sherman. *Animal Behaviour*, **1994**, 48, 19-34.
- [11] LE Higgins. *Journal of Arachnology*, **1995**, 23, 37–43.
- [12] CD Wilcox; SB Dove;WD McDavid; DB Greer. UTHSCSA Image Tool Version 3.0: Freeware software available from the Department of Dental Diagnostic Science at the University of Texas Health Science Center at San Antonio, **2002**, <http://compdent.uthscsa.edu/dig/download.html>.
- [13] Ø Hammer; DAT Harper; PD Ryan. PAST: Paleontological statistics software package for education and data analysis. *Palaeontologia Electronica*, **2001**, 4, 1, 9pp. [http://palaeo-electronica.org/2001\\_1/past/issue1\\_01.htm](http://palaeo-electronica.org/2001_1/past/issue1_01.htm)
- [14] LR Abrenica-Adamat; MAJ Torres; AL Barrion-Dupo; CG Demayo. *Australian Journal of Basic and Applied Sciences*, **2011**, 5, 3,175-184.
- [15] AT Sensenig; I Agnarsson; AT Blackledge. *Journal of Zoology*, **2011**, 285, 1, 28-38
- [16] ME Herberstein; AM Heiling. *European Journal of Entomology*, **1998**, 95, 367—371.
- [17] TA Blackledge; JM Zevernberg. *Ethology*, **2006**, 112, 1194-1201.
- [18] TA Blackledge; CM Eliason. *Biology Letters*, **2007**, 3, 456–458
- [19] IM Tso. *The American Midland Naturalist*, **1999**, 141(2), 238-246.
- [20] TA Blackledge; M Kuntner; I Agnarsson. *Advance Insect Physiology*, **2011** 41,175–262.
- [21] C Boutry; M Rezáč; TA Blackledge. *PLoS ONE*, **2011**, 6, 7, e22467. doi:10.1371/journal.pone.0022467
- [22] HM Peters. *Zoological Journal of Physiology*, **1993**, 97, 245-264.
- [23] RF Foelix. *Biology of Spiders*. Harvard University Press, Cambridge, Massachusetts. **1982**; p306.
- [24] A Walter; MA Elgar; P Bliss; RFA Moritz. *Behavioral Ecology*, **2008** 19(4), 799-804.
- [25] SA Crowe. Exploring the functions of stabilimenta in the banded garden spider, *Argiope trifasciata*. M.S.Thesis. Queen's University (Canada, **2009**).
- [26] IM Tso. *The American Midland Naturalist*, **1999**, 141(2):238-246.
- [27] ME Hauber. *Ethology Ecology & Evolution*, **1998**, 10, 47-54.
- [28] A Pasquet; A Ridwan; R Leborgne. *Animal Behavior* **1994**, 47, 477-480.
- [29] CL Craig; JD Bernard. *Ecology*, **1990**, 71, 616-623.
- [30] CL Craig. *Behavioral Ecology and Sociobiology*, **1994**, 35, 45–52.
- [31] IM Tso. *1996 Animal Behavior*, **1996**, 52, 183–191.
- [32] IM Tso. *Journal of Arachnology*, **1998b**, 26, 101–105.
- [33] AM Heiling; ME Herberstein. **2000** *Ekologia*, **2000**, 19, 97-106.