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Prey-attraction function of stabilimentum in selected A*rgiope* spiders

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ABSTRACT

This study was conducted to examine the prey-attraction hypothesis as function of stabilimentum and to address whether there is a tradeoff between building large undecorated webs and small decorated webs in orb-webs of selected Argiope spiders: A. catenulata, A. luzona, A. appensa, and A. aemula. The present data were consistent with the prey-attraction hypothesis and a tradeoff between stabilimentum-building and a large web area as alternative prey capture strategies. Webs with stabilimentum were more likely to contain more prey in all species observed. Except for A. aemula, webs with longer stabilimentum were more likely to contain more prey. Comparing the number of prey intercepted between webs with and without a stabilimentum showed that more prey was caught in decorated webs in all species observed. Except for A. luzona, webs found nearer the ground were significantly more likely to add stabilimentum. Furthermore, the web area was significantly larger in non-decorated webs than decorated webs in A. catenulata and A. aemula and the stabilimentum length was negatively correlated with web area in A. appensa.

Keywords: prey-attraction hypothesis, stabilimentum, prey, web area, web area

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INTRODUCTION

Spiders in the genus *Argiope*, Audouin 1826, often decorate their nearly inconspicuous orb webs with very obvious white zigzag silk called stabilimentum (plural=stabilimenta) [1][2]. When you look at the structure of stabilimentum, the size, type and form (e.g. number of arms), and frequency of spiders that decorate their webs varies both inter- and intraspecifically [2].

Several hypotheses were proposed to describe the function of stabilimentum but efforts to elucidate its function often yielded conflicting results. Among the major hypotheses regarding the function of stabilimentum, the prey-attraction hypothesis (increasing foraging success; [3][4][5][6][7][8]) received the most attention yet yielded conflicting results[9]. This is based on the idea that web and stabilimentum reflect ultraviolet (UV) light and many insects are attracted to UV [10] because it indicates open sky, or a safe light path [11][12][3].

UV-reflectance as a key luring feature of prey-attraction has been reported by several studies. In the presence of UV light, webs of *Argiope versicolor* juveniles containing discoid decorations captured more *Drosophila* than undecorated webs in Y-choice experiments [10]. In *Octonoba sybotides* webs, *Drosophila* was significantly attracted to decorated webs in UV-positive light [13]. In *Argiope savignyi,* decorated webs intercepted more stingless bees (*Tetragonisca angustula)* than undecorated webs [14]. Artificial webs with stabilimentum from *Argiope aurantia* intercepted more flying insects than the control group of artificial webs containing non-decorative silk from the same area of the web [7]. According to prey-attraction hypothesis, the stabilimentum increases a spider's foraging efficiency by improving web attractiveness luring insects towards the web [11][12][3].

In the present study, a field survey was conducted primarily to test whether webs with stabilimenta intercept more prey compared to webs without stabilimenta and to address whether there is a tradeoff between building large undecorated webs and small decorated webs. In this paper, decorated webs refer to webs spun with stabilimenta while undecorated webs refer to webs without stabilimenta.

MATERIALS AND METHODS

Study Species

Field survey on the function of stabilimentum in four species of *Argiope* (Figure 1) was conducted between 0800 and 2400h in Barangay Apolinario, Tangub, Misamis Occidental, Mindanao, Philippines from January to June 2013.

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

Web Parameters

Among females of the four species of *Argiope*, the following variables were obtained from each web: stabilimentum length (cm), vertical and horizontal web diameter (cm) measured as distance between the lower-and upper-most sticky spirals comprising the capture area, web height (cm) measured as distance between the ground and the lower-most sticky spiral, spider size (cm) measured as the total body length, and stabilimentum presence or absence.

The spider and the stabilimentum in its web were photographed with a ruler on the side (for calibration). The images were then imported to UTHSCSA *Image Tool* software [15] where necessary measurements were done. The web parameters such as vertical web diameter, and horizontal web diameter were directly measured using a ruler. The web area was computed using the estimated formula of [9]: Web Area = **[(dv*0.5) (dh*0.5)] x π**, where d_v is the vertical web diameter of the web measured from the outermost row of capture spiral, d_h is the horizontal web diameter measured from the outermost row of capture spiral and π is the pi value which is equal to approximately 3.14. Webs with discoid stabilimenta were excluded in the analysis.

Testing the prey-attraction function of stabilimentum

Prey presence and number of prey intercepted were recorded. The prey-attraction function of stabilimentum spun by selected *Argiope* spiders was tested by examining if webs with stabilimentum intercepted more prey than those webs without stabilimentum and if an increased likelihood of prey interception was associated with the presence and length of stabilimentum. The association of web area with the occurrence and length of stabilimentum were examined to address whether there is a tradeoff between building large undecorated webs and small decorated webs in orb-webs of selected *Argiope* spiders.

Statistical Analysis:

Statistical Analysis was performed using the PAST (Paleontological Statistics) Software. Linear Correlation analysis was used to determine relationship among stabilimentum (occurrence and length), web area, web height and number of prey intercepted in webs. In terms of stabilimentum occurrence, ranking was employed: absence=0 and present=1. Kruskal Wallis Test was used to determine the significant difference in web area, web height and number of prey captured between decorated and decorated webs.

RESULTS

As shown in Table 1, the occurrence of stabilimentum was negatively predicted with web area in *A. catenulata*, and *A. aemula*, suggesting that larger webs were significantly less likely to contain stabilimentum among these spiders. Considering the web height, webs found nearer the ground were significantly more likely to have stabilimentum in three species-*A. catenulata*, *A. appensa*, and *A. aemula*. The lack of association in web area and web height to occurrence of stabilimentum in *A. luzona* could have been due to small sample size in undecorated webs (N=11). Meanwhile, larger webs tended to have shorter stabilimentum in *A. catenulata*, *A. appensa*, and *A. aemula*. The relationship between the stabilimentum length and the web distance from the ground showed a weak negative correlation in *A. catenulata* only but no correlation in *A. luzona A. appensa* and *A. aemula*.

Table 1. Linear correlation between stabilimentum building and web variables

Spider	Occurrence of Stabilimentum				Stabilimentum Length			
	Web Area(cm^2)		Web height		Web Area (cm^2)		Web height	
	r	*p**	*r*	*p**	*r*	*p**	*r*	*p**
A. catenulata	-0.156 (N=484)	0.0005	-0.336 (N=484)	6.0E-8	-0.142 (N=237)	0.031	-0.128 (N=237)	0.050
A. luzona	-0.059 (N=222)	0.356	-0.098 (N=222)	0.126	0.182 (N=211)	0.200	-0.096 (N=211)	0.135
A. appensa	-0.141 (N=145)	0.076	-0.621 (N=145)	6.3E-11	-0.323 (N=81)	0.025	-0.105 (N=81)	0.471
A. aemula	-0.277 (N=91)	0.010	-0.3771 (N=91)	0.0003	-0.286 (N=50)	0.044	-0.079 (N=91)	0.584

**permut p; for stabilimentum length, undecorated webs were excluded in the data set.*

The number of prey intercepted in orb-webs or NPI (Table 2) was positively correlated to the occurrence and length of stabilimentum in *A. catenulata, A. luzona* and *A. appensa*. In *A. aemula* the NPI is positively correlated with the occurrence of stabilimentum but not with the stabilimentum length. On the contrary, a negative correlation was observed between the web area and NPI in *A. catenulata*, *A. appensa*, and *A. aemula* while the web height was negatively correlated with NPI in *A. catenulata* only.

Table 2. Linear correlation between the number of prey intercepted (NPI) and stabilimentum and web variables

Spider	Occurrence of Stabilimentum		Stabilimentum Length		Web Area (cm^2)		Web height	
	r	*p**	*r*	*p*	*r*	*p**	*r*	*p**
A .catenulata	0.513 (N= 484)	1.5E-33	0.234 N=237	0.0003	-0.111 (N= 484)	0.015	-0.183 (N= 484)	5.6E-5
A. luzona	0.130 (N=222)	0.041	0.134 (211)	0.035	0.077 (N=222)	0.227	0.040 (N=222)	0.537
A. appensa	0.471 (N=145)	2.8E-6	0.356 (N=81)	0.011	-0.323 (N=145)	0.025	-0.105 (N=145)	0.471
A. aemula	0.256 (N=50)	0.015	0.013 (N=41)	0.929	-0.286 (N=50)	0.044	-0.079 (N=50)	0.584

**permut p; for stabilimentum length, undecorated webs were excluded in the data set.*

The web area is significantly larger in webs without stabilimenta (undecorated webs) than in webs with stabilimenta (decorated webs) in only two species observed-*A. catenulata*, and *A. aemula* (Table 3) which also supports the notion of the tradeoff between building large undecorated and small decorated webs. No significant difference in web size between decorated and non-decorated webs in *A. luzona* and *A. appensa*. In congruent with the prey attraction hypothesis, webs spun with stabilimenta were more likely to contain more prey than undecorated webs in four species- *A. catenulata*, *A. luzona*, A. *appensa*, and *A. aemula*.

Table 3. Web size and the number of prey intercepted (NPI) in decorated (with stabilimentum) and undecorated (no stabilimentum) webs

Spider	Web Area			Number of Prey Intercepted		
	With Stab	No Stab	*p**	With Stab	No Stab	*p**
A. catenulata	459.1±189.2 (N=241)	516.3±203.3 (N=243)	1.2E-34	2.97±2.10 (N=241)	0.87±0.12 (N=243)	1.2E-34
A. luzona	700.99+477.44 (N=211)	831.09+552.57 (N=11)	0.55	1.93+2.01 (N=211)	0.72+0.79 (N=11)	0.018
A. appensa	1216.9±393.8 (N=81)	1235.4±463.1 (N=64)	0.880	1.94±0.79 (N=81)	0.80±0.18 (N=66)	6.9E-06
A. aemula	1012.9+316.0 (N=50)	1177.4+253.0 (N=41)	0.010	2.62±2.83 (N=109)	0.78±0.92 (N=78)	0.015

**permut p; Kruskal-Wallis Test; Stab=stabilimentum*

DISCUSSION AND CONCLUSION

For stationary orb-web spiders, such as *Argiope* spp., foraging success is influenced by any tendency of webs either to lure or repel prey [3]. The positive association between the number of prey intercepted and the occurrence of stabilimentum and the observation that webs with stabilimentum were more likely to contain more prey than undecorated webs in orb-webs of *A. catenulata*, *A. luzona*, *A. appensa* and *A. aemula* support the prey-attraction hypothesis. Likewise, the positive association between the number of prey intercepted and length of stabilimentum in orb-webs of *A. catenulata*, *A. luzona,* and *A. appensa* affirms the prey-attraction hypothesis. The lack of association between NPI and stabilimentum length in orb-webs of *A. aemula* could have been due to the availability of insects [16][17] or the intercepted prey were already consumed by the spiders prior to our observation.

The observations that webs found nearer the ground were significantly more likely to be decorated in orb-webs of *A. catenulata*, *A. appensa,* and *A. aemula,* and tended to contain longer stabilimentum among *A. catenulata* were logically consistent with the prey-attraction function of stabilimentum, suggesting that silk decoration or more silk decorations may be required in darker conditions than those in well-lit areas [18]. The vegetation tends to be denser closer to the ground with reduce light penetration. Thus, spiders with higher webs may not need to add stabilimentum or larger stabilimentum to achieve the same prey attractant effect. Furthermore, with denser vegetation, webs lower to the ground may need to be decorated (e.g. *A. catenulata, A. appensa,* and *A. aemula)* or contain longer stabilimentum (e.g. *A. catenulata*) to achieve the same effect as they would in more well-lit conditions [19].

UV-reflectance as a key luring feature of prey-attraction has been supported by several studies. According to [10][13][14][7][11][12][3], stabilimentum increases a spider's foraging efficiency by improving web attractiveness luring insects towards the web. This is because most insects are attracted to ultraviolet reflectance [10] and silk stabilimentum reflecting ultraviolet range [3]. In present study, the prey species observed were mostly flying dipteran insects (61%: mosquitoes, fruitflies, and houseflies) which were reported to have photoreceptors that are very sensitive in the ultraviolet range [20][12][21]. A web with stabilimentum reflects little UV light, provides floral guides, deceiving their prey by mimicking a food resource (e.g. flower; [3]. Also flying insects are attracted to UV-bright silk because it characterizes an open sky, providing free space for flying or escape routes [22]. However, according to [13], insects might respond to UV light as a cue that indicates these objects, although it is uncertain if a single mechanism attracts prey to the web. Moreover, [23] reported a fitness consequence of stabilimentum-building in *Argiope versicolor* spiders. In *A. versicolor,* the growth rate in terms of weight gain and the frequency of stabilimentum-building, as well as the rate of insect interception were strongly positively correlated with each other, suggesting that individuals which decorate their webs at a higher frequency are expected to have a higher growth rate.

The observations that: (1) the likelihood of spinning a stabilimentum decreases with increasing web area in *A. catenulata*, and *A. aemula*; (2) larger webs tended to have shorter stabilimentum in three species- *A. catenulata, A. appensa* and *A. aemula*; and (3) web area was significantly larger in non-decorated webs than in decorated webs in *A. catenulata* and *A. aemula* are consistent with the tradeoff between web area and stabilimentum-building activity. Although there was no significant difference in web area between decorated and undecorated webs of *A. appensa* (Table 3), however, smaller webs were more likely to have longer stabilimentum (Table 1) and the number of prey intercepted was positively associated to both the occurrence and length of stabilimentum (Table 2). Furthermore, more prey was observed in decorated webs than in undecorated orb-webs among *A. catenulata*, *A. luzona*, *A. appensa* and *A. aemula.* Therefore, these results are also consistent with the two hypotheses being tested in this paper: prey-attraction hypothesis and tradeoff between web area and stabilimentum-building activity. As reported by [5], large webs without stabilimentum yield a similar capture success as small webs with “prey-luring decorations” in *Argiope appensa*.

The observed relationship between occurrence or length of stabilimentum and web area in the present study is consistent with several previous studies (e.g. *Araneus eburnus*: [24]; *A. appensa*: [9][1][2]; *A. keyserelingi*: [25][26] *A. trifasciata*: [7]; *A. aurantia* and *A. trifaciata*: [9][19]; *A. luzona* and *A. aemula*: [2]. Less satiated spiders tend to spin larger webs, but were less likely to spin stabilimentum than those more satiated [26]. This finding supports the idea that web decorating is a different foraging strategy compared to building webs with a large capture area. The lack of negative association between the web height, web area and occurrence of stabilimentum in *A. luzona* could have been due to small sample size of undecorated webs (N=11), hence, reduced statistical power.

Prey can be quickly removed from the web after consumption and prey presence in a web can only be assumed to be an approximation of spider foraging success [19]. Therefore, an enclosure study is recommended to compare the prey-capture rates in decorated and undecorated webs and simultaneously address the hypotheses that web size and stabilimentum-building are alternative strategies among these spiders.

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REFERENCES

[1]LR Abrenica-Adamat; MAJ Torres; AL Barrion-Dupo; CG Demayo. *Australian Journal of Basic and Applied Sciences*, **2011**, 5, *3*, 175-184.
[2]LR Abrenica-Adamat; EE Bermudo; MAJ Torres; AL Barrion-Dupo; CG Demayo. Extreme Life, *Biospeology & Astrobiology - International Journal of the Bioflux Society***, 2013**, 5, *1*, 28-37.
[3]CL Craig; GD Bernard. *Ecology*, **1990,** 71:616–623.
[4]CL Craig. *Behavioral Ecology and Sociobiology*, **1994**, 35, 45-52.
[5]ME Hauber. *Ethology Ecology & Evolution*, **1998**, 10:47-54.
[6]IM Tso. *Animal Behavior*, **1996**, 52, 183-191.
[7]IM Tso. *Behavior*, **1998a,** 135, 311-319.
[8]IM Tso. *Journal of Arachnology*, **1998b**, 26:101-105.
[9]TA Blackledge. *Journal of Zoology*, **1998,** 246:21-27.
[10]D Li; LM Matthew; WKS Lim; SL Tay. *Animal Behavior*, **2004**, 68, *3*, 629-635.
[11]TH Goldsmith.. The color vision of insects. In: *Light and Life* (Ed. by W.D. McElroy & B. Glass),Baltimore: Johns Hopkins University Press, **1961**. pp. 771-794.
[12]GG Hu;WS Stark. *Journal of Comprative Physiology*, **1997,** 121, 241-252.
[13]T Watanabe. *Behavioral Ecology*, **1999**, 10:607-611.
[14]D Gálvez. *Journal of Arachnology***, 2011,** 39, 1, 128-132.
[15]UTHSCSA ImageTool, Version 3.0. http://compdent.uthscsa.edu/dig/download.html.
[16] SE Reichert; AB Cady. *Ecology*, **1983**, 64, 899-913.
[17]DH Wise; JL Barata. *Journal of Arachnology*, **1983,** 11, 271-281.
[18]MA Elgar; RA Allan; TA Evans. *Australian Journal of Ecology*, **1996**, 21, 464-467.
[19]SA Crowe. Exploring the functions of stabilimentum in the banded garden spider, *Argiope trifasciata*. M.S.Thesis. Queen's University (Canada, **2009)**.
[20]LG Bishop. *Journal of Comparative Physiology*, **1974**, 91, 267-275.
[21]*LE* Muir; MJ Thorne; BH Kay. *Journal of Medical Entomology*, **1992**, 29:278-281.
[22]CL Craig; GD Bernard; JA Coddington. *Evolution*, **1994**, 48:287-296.
[23]D Li. *Proceedings of the Royal Society B*, **2005**, 272, 1753-1757.
[24]MJ Bruce; AM Heiling; ME Herberstein. *Annales Zoologici Fennici*, **2004**, 41:563-575.
[25]A Walter; MA Elgar; P Bliss; RFA Moritz. *Behavioral Ecology*, **2008** 19(4), 799-804.
[26]ME Herberstein; CL Craig; MA Elgar. *Evolutionary Ecology Research*, **2000**, 2, 69-80.