N O T E

Argiope submaronica (Araneidae) Silk Decoration Does Not Reduce Web Damage by Birds[1]

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Web-decorating behavior is typical of many orb-weaving spiders worldwide. The decoration consists of a visible structure added to the web, made of materials such as prey remains, plant material, egg sacs, or silk (Herberstein et al. 2000, Biol. Rev. 75: 649–669). However, it is not clear why spiders increase the conspicuousness of their webs. The fact that decorations are typical only to diurnal species suggests a visual function (Scharff and Coddington 1997, Zool. J. Linn. Soc. 120: 355–424). Thus, three hypotheses have been proposed and investigated: (a) increasing prey attraction, (b) protecting against predators, and (c) advertising the presence of the web to vertebrates to reduce web damage (Bruce 2006, J. Zool. 269: 89–97). The first two hypotheses have received most support, particularly within the genus *Argiope*, which has become a model genus to study silk decorations (Walter and Elgar 2012, J. Zool. 269: 89–97). The first hypothesis proposes that the ultraviolet (UV)-reflective properties of decorations mimic other natural sources of UV light used by prey (Craig and Bernard 1990, Ecology, 71: 616–623). The second hypothesis proposes that decorations may make the spiders seem larger or camouflage the location of the spider (Bruce 2006). However, the search of a single function has resulted in disagreement, with conflicting results across studies (Théry and Casas 2009, Philos. Trans. R. Soc. Lond. B Biol. Sci. 364: 471–480).

Decorations may have more than one function; for instance, *Argiope trifasciata* Forsskål seems to use decorations for both foraging and defense (Blackledge and Wenzel 2001, Behaviour 138: 155–171; Tso 1996, Anim. Behav. 52: 183–191), thus underscoring the importance of studying multiple functions simultaneously. In this study, I investigated in *Argiope submaronica* Strand, a species that uses web

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decorations to increase foraging success (Gálvez 2009, J. Arachnol. 37: 249–253), whether decorations also advertise the position of the web to birds to reduce web damage. Moreover, the "advertisement" hypothesis has received less experimental testing (Blackledge and Wenzel 1999, J. Arachnol. 37: 249–253; Eisner and Nowicki 1983, Science 219: 185–187; Walter and Elgar 2011, Behav. Ecol. Sociobiol. 65: 1909–1915) as compared to the prey attraction or predator defense hypotheses that have been tested in at least 24 studies (D.G., unpubl. meta-analysis).

Experiments were performed at La Selva Biological Station, Costa Rica, a 1,550-ha reserve in the Atlantic lowlands. *Argiope submanorica* decorates its web with zigzags of silk laid in a variety of designs that include one to four arms of a cross or no decorations in adults (Nentwig and Rogg 1988, Zool. Anz. 221: 248–266). Identities of the species were confirmed using the taxonomic keys of Levi (2004, Bull. Mus. Comp. Zoo. 158: 47–66.).

For the experiment, I used a 300 × 120 × 80–cm tunnel, open at both exits as described in Gálvez (2009). Web treatments were placed on wooden frames at one end of the tunnel on a wooden board and this end of the tunnel was in front of herbaceous vegetation.

I performed a "two-frame-choice" experiment consisting of two frames (34.5 × 45.0 cm) placed next to each other at the end of the tunnel with the different web treatments; one bearing a decorated web and one bearing an undecorated web (as described in Gálvez 2009). Sixteen unique hummingbirds (five species: *Amazilia tzacatl* La Llave, $n = 3$; *Thalurania colombica* Bourcier, $n = 10$; *Threnetes ruckeri* Bourcier, $n = 2$; *Phaetornis superciliosus* L., $n = 1$) were released, each in independent trials, at the opposing end of the tunnel from a box on the ground, so they could fly out through one of the web treatments. I exposed birds only to intact webs and replaced damaged webs after each trial. I used a new pair of spiders of similar size (on decorated versus undecorated webs) every four birds ($n = 16$).

Birds did not preferentially fly through any of the web treatments (eight cases for each; binomial test, $n = 16$, $P = 0.6$), indicating that the decoration did not advertise the position of the web. It seems unlikely that the decoration of *A. submaronica* has an advertisement function since the spiders often build their webs in sheltered locations, which makes them unlikely to be encountered by birds during their flights, a web-building behavior that is probably common to most *Argiope* species (Herberstein et al. 2000). Species that build their webs in exposed positions are more likely to use decorations for this function (e.g., *Gasteracantha cancriformis* L., Jaffé et al. 2006, J. Arachnol. 34: 448–455).

Studies that previously tested this hypothesis and found evidence in favor used correlational data (Kerr 1993, Pac. Sci. 47: 328–337), artificial stabilimenta (paper, Eisner and Nowicki 1983), or webs outside of their sheltered locations (Blackledge and Wenzel 1999), which may not provide relevant biological information. Overall, I did not find evidence that the decoration of *A. submaronica* has the dual function of foraging (Gálvez 2009) and advertisement. Whether the decorations provide defense against predation remains to be investigated. However, it is proposed that there is a signaling conflict since the decoration can attract both prey and predators; thus, the frequency of the decorating behavior may vary according the predation risk (Bruce et al. 2001, J. Evol. Biol. 14: 786–794.; Cheng and Tso 2007, Behav. Ecol. 18: 1085–1091). For this reason, *Argiope* provides a system to study the effect of multiple selective forces (e.g., prey, predators, physiology, environment) on the phenotypic plasticity of this particular trait (Herberstein et al. 2000; Walter and Elgar 2012, Biol. Rev. 87: 686–700).

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