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STABILIMENTA AND BARRIER WEBS IN THE ORB WEBS OF *ARGIOPE ARGENTATA* (ARANEAE, ARANEIDAE) ON DAPHNE AND SANTA CRUZ ISLANDS, GALAPAGOS

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ABSTRACT

Stabilimenta and barrier webs in *Argiope argentata* orb-webs were investigated on Daphne and Santa Cruz Islands in the Galapagos. Based on this census, I propose that the barrier web supports and strengthens the orb-web and is therefore common in webs found in windy areas, while the stabilimentum is most likely an anti-predator device.

INTRODUCTION

Orb webs of many Araneidae and Uloboridae have ribbons or tufts of silk arranged in a species specific pattern in addition to the web proper. These structures have been variously termed decorations (McCook, 1889), stabilimenta (Comstock, 1912), or devices (Hingston, 1927; Ewer, 1972). Stabilimenta are often variable within webs of a species at any given locality, both in frequency of occurrence and in form or pattern (Marson, 1947a, 1947b; Marples, 1969; Robinson and Robinson, 1970; Ewer, 1972).

Stabilimenta may either reduce the effectiveness of visual predators (Hingston, 1927) or strengthen the web (McCook, 1889; Simon, 1895). Robinson and Robinson (1970) reviewed the functions attributed to stabilimenta by various authors. They argued that although some stabilimenta may serve to conceal the spider on its web, the "cross" stabilimentum of adult *Argiope argentata* in Panama may actually cue visually orienting predators; flycatchers learned to use stabilimenta as cues in prey location.

Another feature of some orb webs (e.g., those of *Argiope* species, *Nephila*, and *Metepeira*) is the barrier web or stopping maze, an irregular tangle of non-sticky threads on one or both sides of the orb web. The barrier web may protect the spider from predators by acting as a mechanical barrier, early warning system, or deterrent to visually orienting flying predators.

Observations reported here of webs of *Argiope argentata* on Santa Cruz and Daphne Islands in the Galapagos archipelago suggest that the barrier web may function as a strengthening device, while the stabilimentum is most likely important as an anti-predator device.

METHODS

Presence or absence of barrier webs and stabilimenta, and patterns of stabilimenta where present were noted on Daphne Island and at Bahia Borrero on the north shore of Santa Cruz Island during December, 1973. Most webs were of young spiders; very few adults were seen. In all study areas, *A. argentata* webs tended to concentrate on or beneath *Opuntia* (prickly pear cactus) plants up to a height of about 2 meters. Spiders were separated into four easily recognizable size classes: $\leqslant 2$ mm, 3-4 mm, 5-7 mm, and $\geqslant 8$ mm. Some 12 mm individuals were adults.

Daphne Island is a small (0.34 km^2), extinct volcanic cone, about 8 km off the north shore of Santa Cruz Island. It is topped by two adjoining craters: a small upper crater and a large lower crater. The vegetation is of the "arid zone" type (Wiggins and Porter, 1971), dominated by *Bursera* (Palo Santo) trees, *Opuntia*, *Croton*, and *Chamaesyce*. *Croton* and *Bursera* were mostly leafless and the ground vegetation was sparse and patchy, giving the island a dry appearance (Fig. 1). Strong, gusting winds from the east

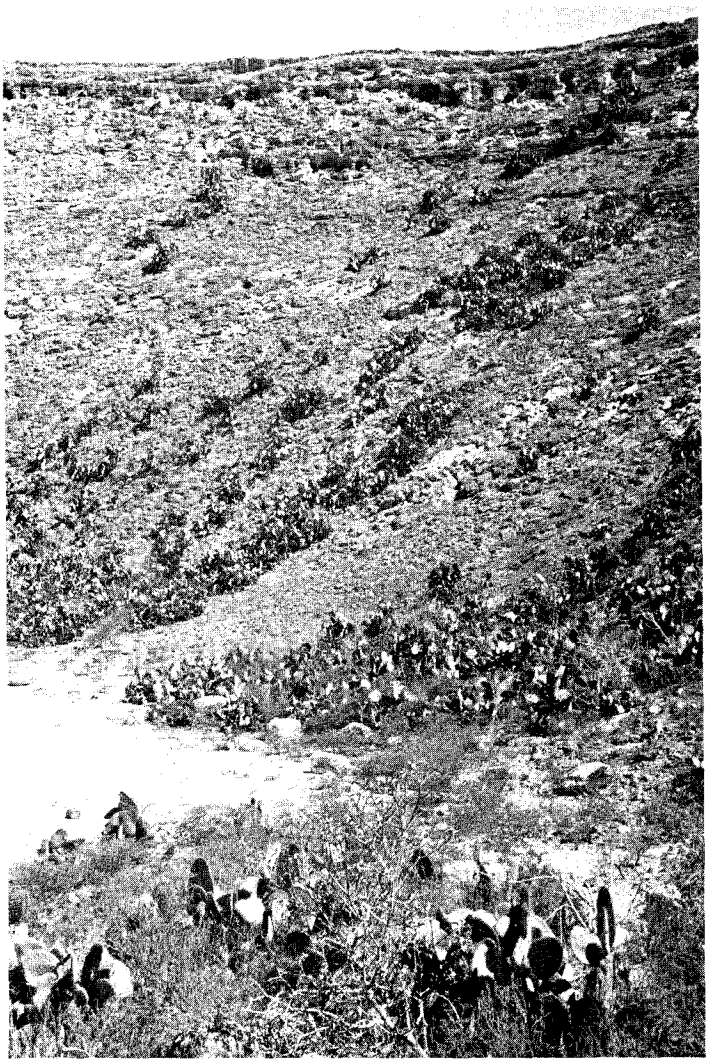

Fig. 1.–The lower crater floor and east wall, Daphne Island.

prevailed during the day; these were especially strong on the rim of the craters ("the plateau"), and somewhat less strong and less consistent in direction inside the craters. *A. argentata* webs were examined both on the plateau and on the lower, inner slopes of the lower crater.

Bahia Borrero is a sheltered bay on the north coast of Santa Cruz Island (902 km^2). Webs of *A. argentata* were observed in the flat "grassland" area immediately behind the beach (Fig. 2). Vegetation in this area consisted mainly of *Opuntia*, leafless *Bursera, Croton,* clumps of *Alternanthera* and *Waltheria* shrubs, and in contrast to the sparse ground vegetation on Daphne, patches of dried grass and annuals. A mild breeze usually came off the land during the day and from the sea at night. Strong winds were not encountered during a seven day stay at Bahia Borrero.

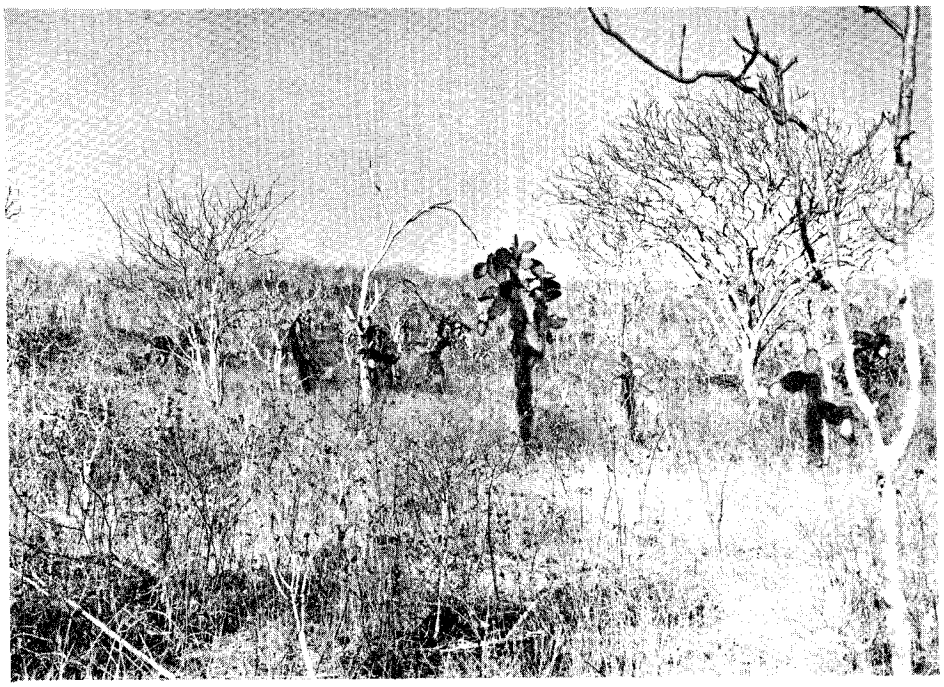

Fig. 2.–"Grassland" habitat, Bahia Borrero, Santa Cruz Island.

RESULTS AND DISCUSSION

1. The stabilimentum–Two basic stabilimentum patterns are found in webs of *A. argentata*: (a) the "disc" stabilimentum, a tightly woven disc of white silk covering the hub (Robinson and Robinson, 1970, Fig. 6), and (b) the "cross" stabilimentum, four ribbons of zigzag silk forming the arms of a diagonal cross, but without crossing each other at the hub (Fig. 1). Incomplete cross stabilimenta may be found, with one to three arms of the cross in several possible combinations.

The frequencies of occurrence of webs without stabilimenta and webs with various patterns of stabilimentum of Bahia Borrero and on Daphne Island are shown in Table 1. The percentages of webs with stabilimenta of three size classes of spiders on Daphne and on Bahia Borrero are shown in Fig. 3.

Table 1.–Numbers and percentages of *A. argentata* webs (all size classes combined) with and without stabilimenta on Daphne Island and on Bahia Borrero, Santa Cruz Island. Stabilimenta are separated into six patterns. The hub is represented by + and the stabilimentum by diagonal lines.

Stabilimentum Type		Daphne Island				Bahia Borrero	
		Plateau		Lower Crater			
		No.	%	No.	%	No.	%
None		46	73.0	61	78.2	78	58.2
⟍+⟍	diagonal	12	19.0	7	9.0	24	17.9
⟋+⟋		4	6.4	8	10.2	16	11.9
⟋+	below hub	0		1	1.3	3	2.3
+⟍		1	1.6	0		5	3.7
⟍+⟋	cross	0		1	1.3	1	0.8
Disc (trace)		0		0		4	3.0
Other		0		0		3	2.2
Total		63		78		134	

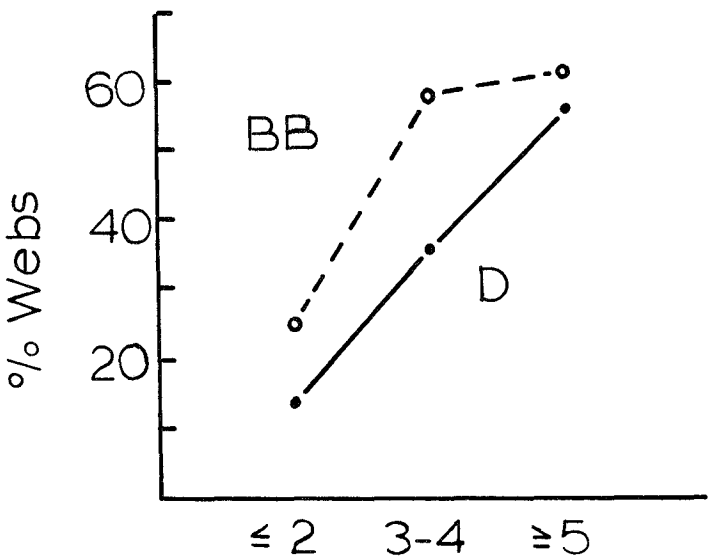

Fig. 3.–Percent *A. argentata* webs with stabilimenta (all forms combined) for three size classes of individuals: ≤ 2 mm, 3-4 mm, and ≥ 5 mm. BB = Bahia Borrero, Santa Cruz Island, D = Daphne Island (two sites combined).

Several points emerge from these comparisons:

(a) Stabilimenta were almost twice as common in Bahia Borrero webs (41.8% of webs with stabilimenta) than in Daphne webs (27.0% and 21.8% of webs with stabilimentum).

(b) The most common stabilimentum type at all locations was a single diagonal line ⟋+⟋ or ⟍+⟍. This is in marked contrast with Robinson and Robinson (1970) who found the most common form in webs of adult individuals in Panama to be one or two arms below the hub, ⟋+ , +⟍ , or ⟋+⟍ .

(c) The complete cross stabilimentum was rare at all locations.

(d) Disc stabilimenta were not found in Daphne webs, and only rarely in Bahia Borrero webs. These latter were faint discs in webs of 2 mm individuals. Two webs of 3-4 mm spiders had a diagonal line with a trace of a disc at the hub.

(e) The frequency of occurrence of stabilimenta increased with size (age) of the spider, both on Daphne and on Bahaia Borrero.

2. The barrier web–Barrier webs may occur on one or both sides of the orb. Those occurring on one side only usually face the spider's dorsal side (dorsal barrier web). The frequencies of occurrence of webs with and without barrier webs at all three sites are shown in Table 2. Percentages of webs with barrier webs of three size classes of spiders are shown in Fig. 4.

Table 2. Numbers and percentages of *A. argentata* (all size classed combined) with and without barrier webs on one or both sides of the web.

Barrier web Type	Daphne Island				Bahia Borrero	
	Plateau		Lower Crater			
	No.	%	No.	%	No.	%
None	17	27.0	28	35.9	89	66.4
One-sided Barrier Web	45	71.4	47	60.3	24	25.4
Two-sided Barrier Web	1	1.6	3	3.8	11	8.2
Total	63		78		134	

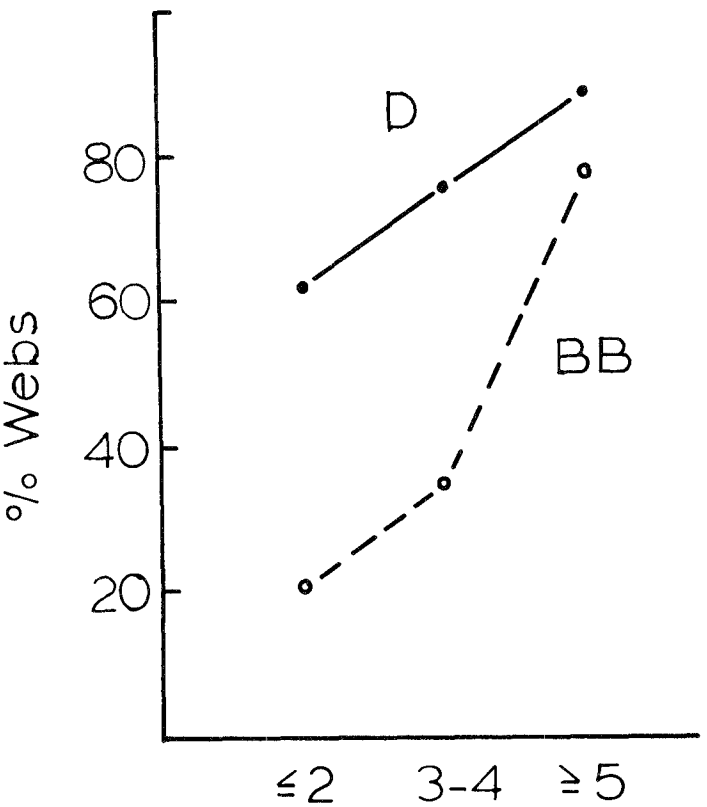

Fig. 4.–Percent *A. argentata* webs with barrier webs (one and two-sided combined) for three size classes of individuals: ≤ 2 mm, 3-4 mm, ≥ 5 mm.

The following results are emphasized:

(a) More than two-thirds of the webs on Daphne Island had barrier webs, as compared with about one-third of the webs on Bahia Borrero.

(b) A slightly greater proportion of plateau webs on Daphne had barrier webs (73.0%) than did lower crater webs (64.1%). This is consistent for all size classes of spiders.

(c) Dorsal barrier webs were most common; only a small proportion of webs had mazes on both sides of the orb.

(d) The frequency of occurrence of barrier webs increased with size (age) of the spider. This is less obvious on Daphne, where a high proportion of webs of all size classes had barrier webs.

If stabilimenta are indeed web strengthening elements, then one would expect to find a higher frequency of occurrence in Daphne webs which were exposed to persistent high winds. This is not the case; stabilimenta were less common on Daphne than on the sheltered grassland site at Bahia Borrero. Robinson and Robinson (1970) suggested that since the lower part of an *Argiope* web is the larger, this section would need the most strengthening, thereby explaining the high frequency (61.4%) of webs in Panama with a stabilimentum consisting solely of one or two ribbons below the hub. This was not the case on Daphne of Bahia Borrero: only 5.9% of the webs with stabilimenta on Daphne, and 14.3% of those with stabilimenta on Bahia Borrero had ribbons beneath the hub alone.

I suggest that the infrequent occurrence of stabilimenta in Daphne webs is due to a lack of visually hunting predators. Predation on *Argiope* was never observed; a list compiled of possible predators on *A. argentata* and their occurrence on Daphne Island and on Bahia Borrero (Table 3) suggests, however, that the latter site has more avian

Table 3.—Possible predators of *A. argentata* on Daphne Island and on Bahia Borrero, Santa Cruz Island (S = Sighted, NS = Not sighted, (S) = Sighted, but rare, + = Probable predator, low level ++ = Probable predator, high level, – = Unlikely predator). The list of birds is derived from Harris (1973).

Birds	Daphne	Bahia Borrero
Coccyzus melacoryphus (dark-billed cuckoo)		NS, ++
Myiarchus magnirostris (large-billed flycatcher)		S, +
Nesomimus parvulus (Galapagos mockingbird)		S, ++
Dendroica petechia (yellow warbler)	(S), +	S, +
Geospiza scandens (cactus finch)	S, –	S, –
Chamarynchus parvulus (small tree-finch)		S, ?
Certhidea olivacea (warbler finch)	S, –	S, –
Lizards		
Tropidurus sp.	S, –	S, –

predators. These include such species as the cuckoo (*Coccyzuz melacoryphus*) and the Galapagos mockingbird (*Nesomimus parvulus*) which are highly insectivorous and may prey extensively on spiders. It is generally thought that the disc stabilimentum, typical of immature individuals, is a concealing device (McCook, 1889; Hingston, 1927; Robinson and Robinson, 1970); when disturbed the spider shuttles through the web and hides behind the disc. The low incidence of disc stabilimenta in Galapagos webs, and in Daphne webs in particular, further argues for a paucity of predators.

The increase in frequency of occurrence of stabilimenta with spider size remains unexplained: perhaps avian predators are more likely to take larger individuals. Daphne and Bahia Borrero *Argiope* may be protected to some extent by *Opuntia* cacti; small individuals are less conspicuous (to humans) among *Opuntia* spines than are large individuals. The effects of web location and the degree of protection afforded by surrounding vegetation need to be examined.

Orb webs on Daphne tended to be associated with barrier webs; this is particularly true of plateau webs which were exposed to strong winds. Less than half the Bahia Borrero webs had barrier webs. The orb web of *A. argentata* is torn down and renewed daily or every two days (with the exception of females about to spin coccoons or young about to molt). The barrier web, however, is a permanent structure that is not renewed unless the spider moves to a new location, and may be particularly useful under conditions where (a) web supports are scarce, and (b) strong winds make it necessary to anchor the web securely.

It is likely that barrier webs have more than one function. In some locations their main function may be protective, as suggested by Comstock (1912), and in others it may be mechanical support for the orb web. Other web types that are adapted to conditions of either high winds or heavy rainfall, e.g., *Cyrtophora* spp. (Blanke, 1972; Lubin, 1973) and perhaps *Metepeira* sp. (personal observations on the Galapagos), also have complex barrier webs. These may also serve as moisture gathering devices.

CONCLUSIONS

The high incidence of barrier webs and low frequency of stabilimenta in webs of *A. argentata* on Daphne Island in comparison with those on Bahia Borrero, Santa Cruz Island led me to reconsider the functions of these structures. I suggest that barrier webs help support the orb web and are, therefore, more common in Daphne webs which are exposed to strong winds. If stabilimenta are protective devices, one would predict a higher incidence in webs on Bahia Borrero where there are more potential predators.

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Fig. 2.—"Grassland" habitat, Bahia Borrero, Santa Cruz Island.

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