DO FEMALE *MIAGRAMMOPES ANIMOTUS* (ARANEAE, ULOBORIDAE) SPIN COLOR-COORDINATED EGG SACS?

Like other members of their pantropical genus, *Miagrammopes animotus* Chickering females spin capture webs consisting of only a few threads and monitor them from one of their attachment points (Lubin 1986; Lubin et al. 1978). In this position, the spiders' cylindrical abdomens, long, slender legs, and linear web-monitoring postures (Opell 1987) contribute to their twig-like protective resemblance. Unlike most members of the family Uloboridae that produce stellate or lenticular egg sacs (Opell 1984), *Miagrammopes* females construct cylindrical egg sacs consisting of two columns of eggs wrapped tightly with tubuliform (cylindrical) gland silk (Foelix 1982; Lubin et al. 1978; Opell 1984). The color of both *M. animotus* females and their egg-sac-wrapping silk ranges from light tan to brownish gray to dark, rusty red. During the day, females hang contiguously with their egg sacs, maintaining fourth leg contact with the egg sac and first leg contact with a support to which their web is attached (Fig. 1). This alignment of females with their egg sacs enhances the twig-like appearance of both and may reduce threats to the spiders from visually hunting predators such as lizards, birds, wasps, and other spiders, and to their egg sacs from these predators and egg parasitoids. If a female's proximity to her egg sac serves primarily to permit her to chase away egg parasitoids, the pair's stick-like appearance places her in less jeopardy while she tends her egg sac.

Unless the colors of a female and her egg sac are similar, each would appear more distinct and the crypsis of both would be compromised. This study tests the hypothesis that the colors of *M. animotus* females and their egg sacs are linked by determining if the colors of females and sacs are significantly correlated. It was conducted from 20 February to 10 March, 1987 at the Center for Energy and Environmental Research's El Verde field station, located in the Luquillo National Forest of Puerto Rico.

During day and night field observations, I collected a total of 94 *M. animotus* females and their egg sacs. After accumulating 7-21 female-egg sac pairs, I separated each female from her egg sac and placed them in separate vials with matching numbers. To quantify color, I removed each spider and egg sac from its vial, placed it directly onto the paint chips of a Naturalist's Color Guide (NCG) (Smithe 1975), and recorded the best color match. Specifically, I used the 1981 color dilution series 1 and 2 of sepia and raw umber pigments and series 1 of Vandyke brown pigment. This provided 25 possible colors, 13 of which were matched by females and egg sacs. I scored egg sac and spider color in separate observational series conducted from 1400-1700 under natural light. If the dorsal

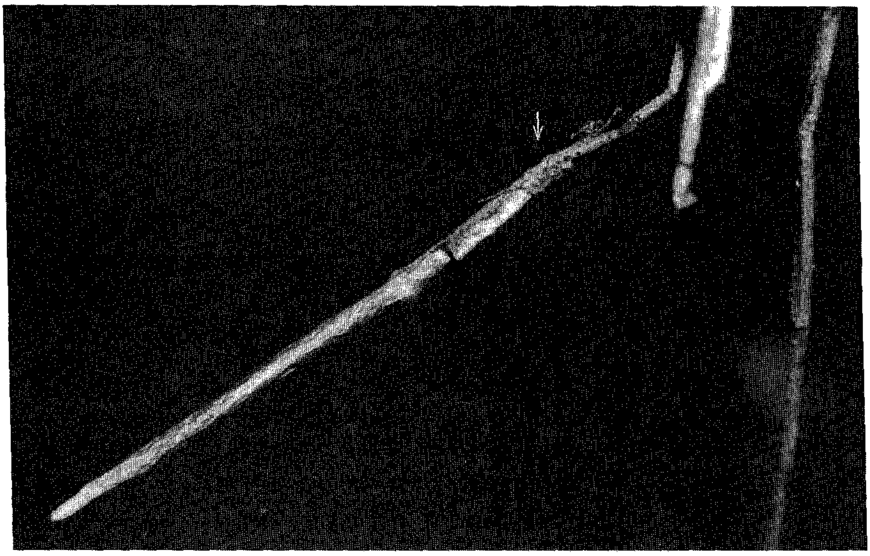

Figure 1.—A female *Miagrammopes animotus* (arrow) monitoring her cylindrical egg sac.

surface of a female's abdomen was made noticeably lighter by guanine deposits, I selected the best match of the spider's cephalothorax, legs and lateral abdominal regions.

Each color in the NCG has a Munsell Notation that provides range, value, and chroma indexes. Range has ten categories extending from red through red purple and each category has ten subdivisions. All spiders and egg sacs collected were in the yellow-red and yellow ranges. Value indicates the "darkness" of the color as it would appear in the absence of color vision: black is 0, white is 10. Chroma is an open-ended scale, specifying the intensity of a color's hue. Figure 2 presents the distribution of these three indexes for *M. animotus* females and egg sacs.

Female and egg sac colors are significantly correlated as measured by all three indices: $r = 0.35$ (range), $r = 0.58$ (value), $r = 0.31$ (chroma); $p < 0.003$. Spiders were more reddish yellow than their egg sacs (mean spider range 8.6, SD 1.8; egg sac mean 9.4, SD 1.4), were darker than their egg sacs (mean spider value 4.1, SD 0.7; egg sac mean 5.2, SD 1.1), and had less highly saturated colors than their egg sacs (mean spider chroma 2.7, SD 0.8; egg sac mean 3.2, SD 1.2). Standard errors for spider-egg sac differences were: range 0.2, value 0.1, and chroma 0.1

Just as background selection enhances the cryptic appearance of insects and spiders (e.g., Malcom and Hanks 1973; Opell 1986; West and Hazel 1979) and protects them from predation (e.g., Erichsen et al. 1980; Sims and Shapiro 1983; West and Hazel 1982), the mechanism linking spider integument and egg sac silk pigmentation probably optimizes the protective resemblance of the pair. The similarity of spider and egg sac color range ("color") should make the pair less conspicuous to predators with color vision, whereas the similarity of color value ("grayness") should make them less conspicuous to predators that lack color vision or to those vertebrates whose vision relies more heavily on rods than color-sensitive cones under the low light conditions of the forest understory (Levine 1985).

Conspicuous guanine deposits were not present in most spiders and seemed to be more common in lighter specimens, where there was little pigmentation to mask them. Because of their mottled nature and dorsal concentration, these

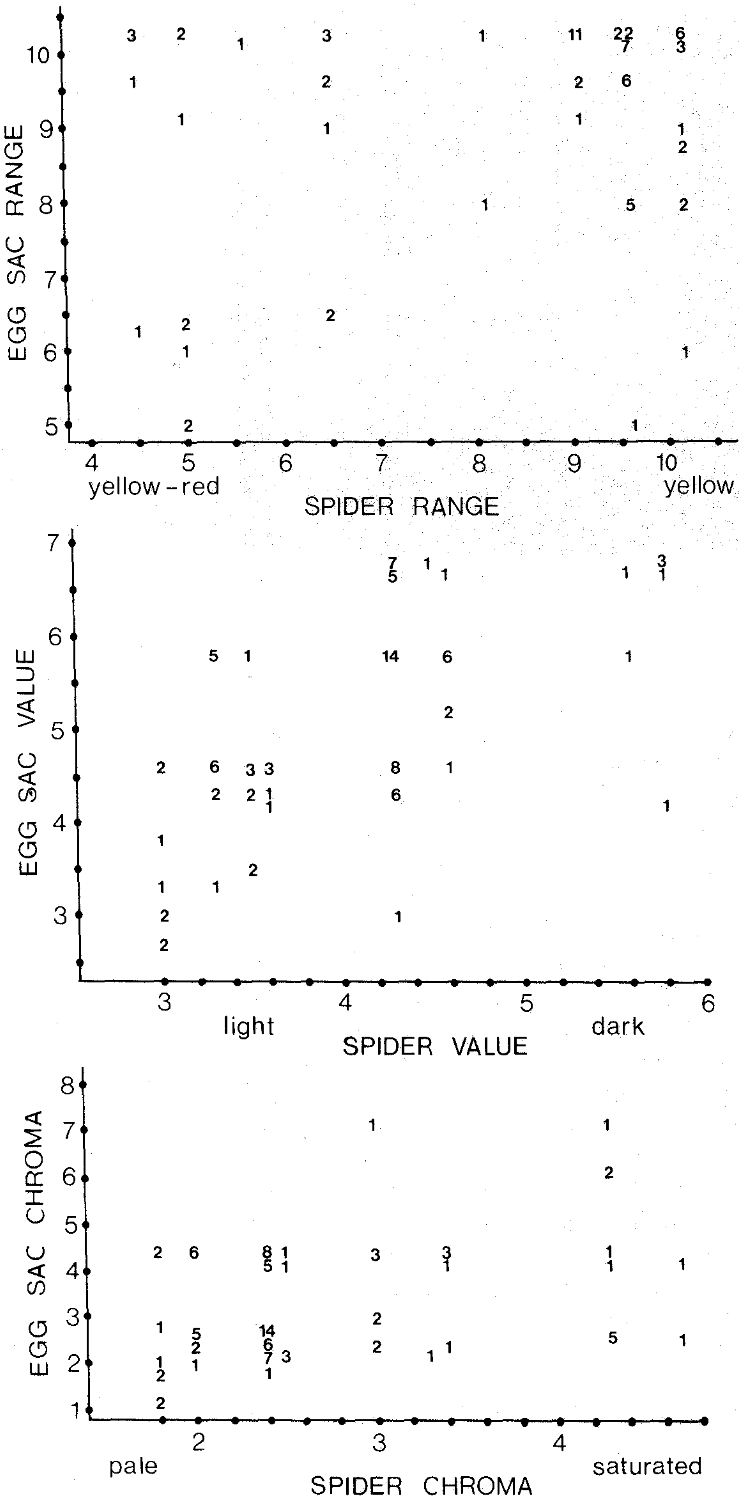

Figure 2. The association between female and egg sac color indexes.

deposits probably do not create significant abdominal color dichotomies that are visible ventrally or laterally.

The color similarity between *M. animotus* females and their egg sacs may be explained either genetically or dietarily, although in spiders there seems to be no clear evidence of the latter (Holl 1986). If metabolized prey pigments are incorporated into both a female's integument and egg sac silk, then feeding history could explain this similarity. If a spider's integumental pigmentation is genetically determined, then these genes may also regulate the color of egg sac silk. During this study I often collected females having greatly different colors from the same bamboo plant or dead palm frond. Although their diets should have been very similar, this observation does not rule out the effects of single, heavily pigmented prey on spider color. However, it does suggest that *M. animotus* do not change their colors to match their backgrounds as do some spiders (see Holl 1986 for a review).

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