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The Effect of Female Ornamentation on Aggressive Male-Male Interactions in the Striped Plateau Lizard (Sceloporus virgatus)

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The effect of female ornamentation on aggressive male-male interactions in the striped plateau lizard (*Sceloporus virgatus)*

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Introduction

Sexual selection theory proposes that the fitness of an individual is dependent on its ability to acquire mates. There are two main categories of sexual selection: intrasexual selection (between members of the same sex) and intersexual selection (between members of the opposite sex). Intrasexual selection most often leads to male-male competition and fighting while intersexual selection often leads to female mate choice and male ornamentation (Amundsen 2000).

While it is usually the males of a species that have sexual ornamentation, among the striped plateau lizards (*Sceloporus virgatus)* the females have two small orange patches on their throats that appear during breeding season in the summer. The orange patch has been found to stimulate male courtship towards the females (Weiss 2002) and predicts the phenotypic quality of the female (Weiss 2006).

Sceloporus virgatus males lack sexually selected ornamentation, having only a reduced blue throat patch also present in related species. This blue patch has been found to have no effect on female mate choice and little effect on male-male interactions (Abell 1999, Quinn and Hews 2000). The reproductive success of males is primarily influenced by male-male aggression and territory control (Vinegar 1975, Abell 1997).

The presence of the female ornamentation and male competition in *Sceloporus virgatus* creates an opportunity to examine how multiple sexually selected traits interact. Using a series of behavioral trials I examined:

How is male aggressive competition is influenced by the female's ornamentation?

I predicted that there will be a positive relationship between the size or intensity of the female ornament and the degree of male-male aggression.

Methods

Between May 22nd and June 20th, 2009, lizards were collected and housed in trial groups of 1 female and 2 males. The lizards were housed in such a way that all lizards were in separate tanks, and the males could see the female but not each other.

After five days both males were placed in the female tank and videotaped (n = 51 trials). The videotapes were then analyzed using an ethogram (a list of behaviors) modified from Weiss and Moore (2004), which included head bobs, pushups, full show holds, full show displays, face offs, charges, bites, and struggles.

The area of a female patch was measured using Adobe Photoshop and The National Institute of Health's ImageJ. The chroma, brightness and hue of the patch were measured using an Ocean Optics spectrometer. Additional female characteristics, including mass, snout to vent length and ovarian follicle diameter were also measured.

Aggression was quantified by running a principal component analysis on the measured male behaviors. Only males that performed aggressive actions were analyzed. The PCA provided me with 4 metrics of male aggression, interpreted as: medium aggression score, high aggression score, low aggression score and pushup to head bob ratio.

Results

Table 1. Multivariate regression of the relationship between female patch characteristics and male aggression scores.

		Color variables[b]			
PC Weighted scores	Full model[a]	Area	Brightness	Chroma	Hue
Medium aggression score	**2.93; 4,20 (0.047)**	0.05 (0.61)	**-0.89 (0.02)**	0.17 (0.62)	0.03 (0.93)
High aggression score	1.56; 4,20 (0.225)	-0.07 (0.42)	**-0.67 (0.03)**	-0.07 (0.80)	0.18 (0.47)
Low aggression score	1.73; 4,20 (0.182)	-0.02 (0.75)	-0.08 (0.75)	**0.54 (0.04)**	-0.33 (0.88)
Push-up to head bob ratio	0.23; 4,20 (0.92)	0.01 (0.92)	-0.09 (0.75)	-0.18 (0.51)	0.06 (0.78)

[a] Cells show F statistic, degrees of freedom and *P* value (in parenthesis).
[b] Cells show standard coefficient and *P* value (in parenthesis).

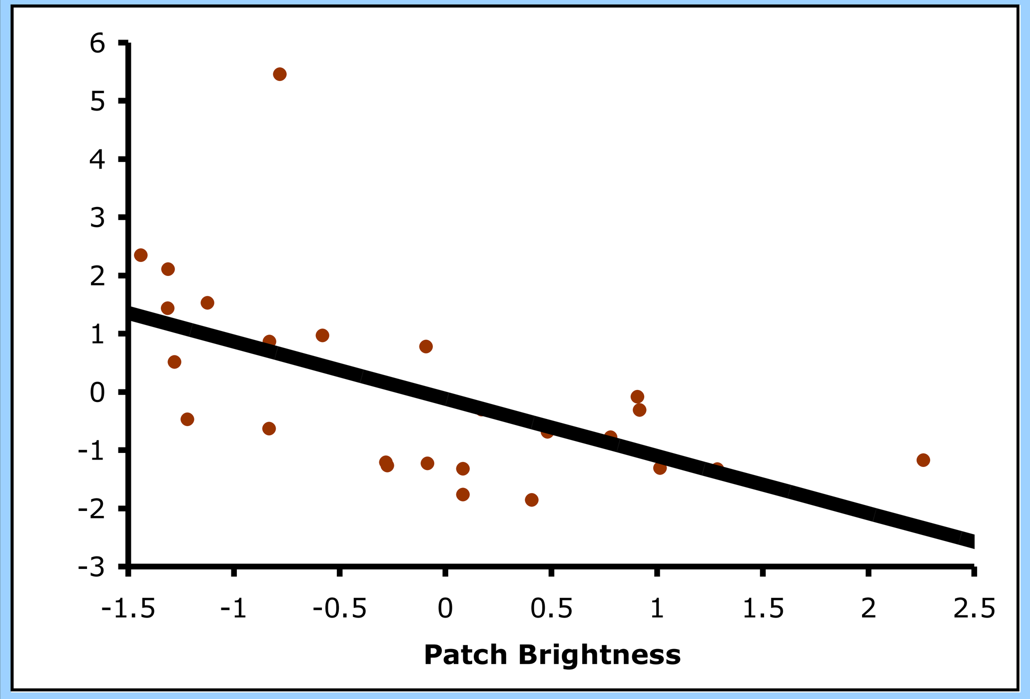

Figure 1. **Regression between female patch brightness and medium aggression score for the two males.** Medium aggression score was negatively related to the brightness of the patch. Males exposed to a female with a darker patch generally had a higher score (R^2 = 0.33, F = 11.25, df = 1,23, p = 0.003).

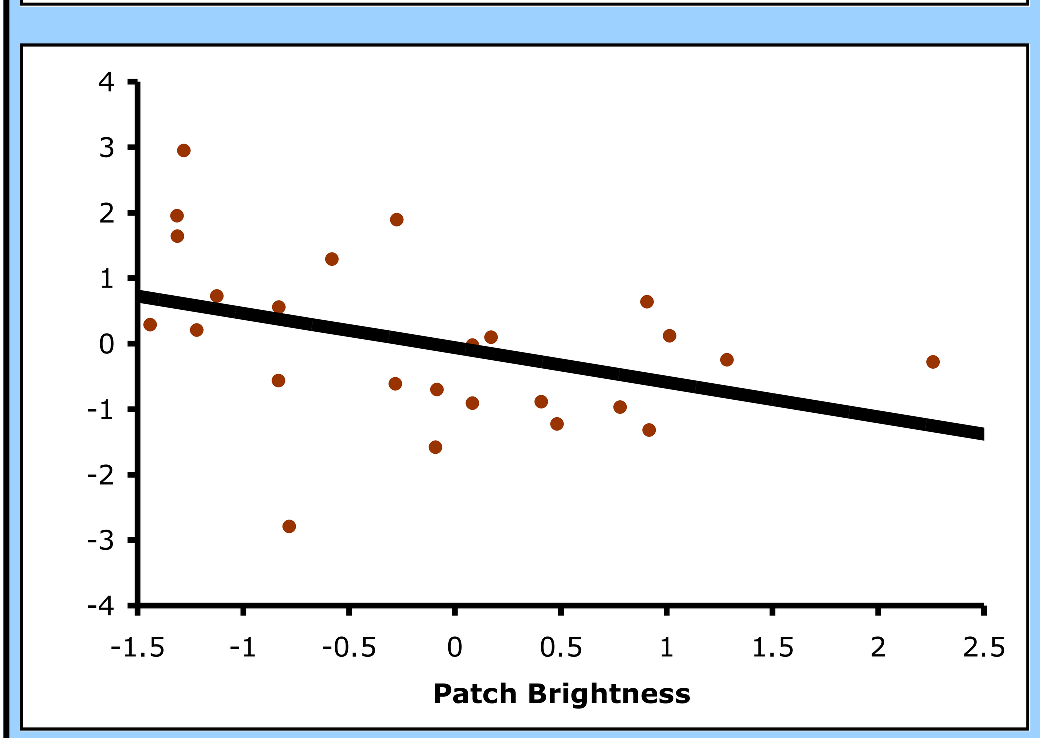

Figure 2. **Regression between female patch brightness and high aggression score for the two males.** High aggression score was negatively related to the brightness of the patch. Males exposed to a female with a darker patch generally had a higher score (R^2 = 0.16, F = 4.36, df = 1,23, p = 0.048).

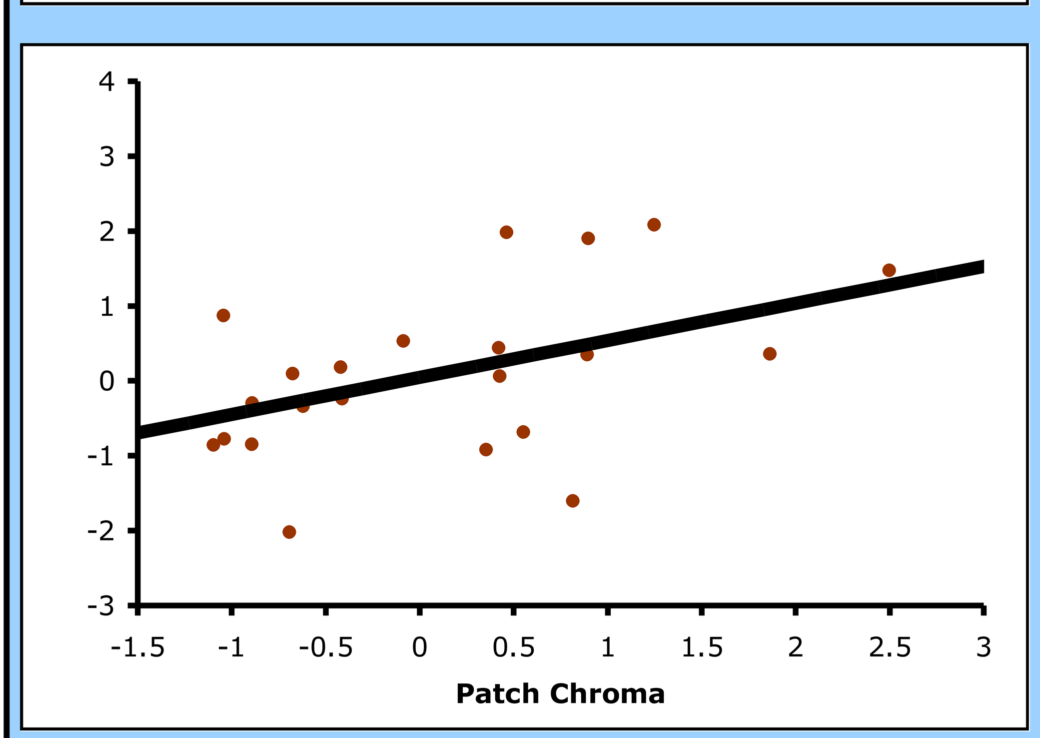

Figure 3. **Regression between female patch chroma and low aggression score for the two males.** Low aggression score was positively related to the chroma of the patch. Males tended to have a higher score when exposed to a female with a higher patch chroma (R^2 = 0.24, F = 7.36, df = 1,23, p = 0.012).

Discussion

Based on my data it is clear that male-male aggression is correlated to aspects of the female's patch. Furthermore, the brightness of the patch seems to correlate strongly with the quantity of both medium aggression behaviors (high energy cost) and high aggression behaviors (high risk of injury), with darker patches leading to an increased amount of both behaviors.

These results were interesting, because while past studies have found that male *S. virgatus* increase their courtship behavior towards females with darker patches (**Weiss 2002)**, more recent studies have found that female patch area is more strongly correlated with female phenotypic quality (**Weiss 2006)**.

There are three possible reasons that explain why there seems to be this misalignment between male behavior and female quality indicators. 1) Males are better able to judge female patch size indirectly by examining the highly correlated brightness of the patch; 2) different aspects of the female's patch lead to different behaviors by males. This may be because different patch qualities predict different aspects of a female's quality. In this study I found that the size of the female's ovarian follicles was positively correlated with the darkness of the patch. 3) Different aspects of the female's patch predict her quality differently from year to year, This may, perhaps, depend on local variation from year to year in either the environment or the genetics of the population.

Clearly, further studies need to be conducted in order to determine which of these hypotheses hold true for the *S. virgatus* system. Future studies should include 1) behavioral tests to determine whether males are better able to differentiate between the size or the color of the patch, 2) parallel studies of both male-male aggressive behavior and male courtship behavior using the same paint modified females, and 3) a multiyear study of female quality indicators.

Acknowledgment

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Work Cited

Abell, AJ. 1997. Estimating paternity with spatial behaviour and and DNA fingerprinting in the striped plateau lizard, *Sceloporus virgatus* (Phrynosamatidae). Behavorial Ecology and Sociobiology 41: 217 – 226.

Abell, AJ. 1999. Removal of an evolutionarily-reduced color signal, and restoration of the signal to the ancestral state, influence male-male interactions in the striped plateau lizard, *Sceloprus virgatus*. Bulletin of the Maryland Herpetological Society Society 35: 115-42.

Amundsen, T. 2000. Why are female birds ornamented? Trends in Ecology and Evolution 15: 149 -155.

Quinn, VS, Hews DK. 2000. Signals and behavioural responses are not couples in males: aggression affected by replacement of an evolutionarily lost colour signal. Proceedings of the Royal Society of London B - Biological Sciences 267: 755 – 758.

Vinegar, MB. 1975b. Comparative aggression in *Sceloporus virgatus*, *S. undulates consobrinus,* and *S. u. tristichus* (Sauria: Iguanidae) Animal Behaviour 23: 279 – 286.

Weiss, SL. 2002. Reproductive signals of female lizards: pattern of trait expression and male response. Ethology 108: 793-813.

Weiss, SL. 2006. Female-specific color is a signal of quality in the striped plateau lizard (*Sceloporus virgatus)*. Behavioral Ecology 17: 726-732.

Weiss, SL, Moore, MC. 2004. Activation of aggressive behavior by progesterone and testosterone in male tree lizards, *Urosaurus ornatus.* General and Comparative Endocrinology 136: 282 – 288.