

Sexual Coloration and Performance Capacity in Male Side-blotched Lizards (*Uta stansburiana*)

Forrest Jensen, Spencer B. Hudson, Susannah S. French
Utah State University Biology Department, Logan, Utah



Abstract

In many species of lizards, males fight over territories that allow them access to females, and during these interactions males will display sexual signals to competing individuals. Social signals such as coloration, are seemingly favored by sexual selection as they are thought to provide information about individual quality, such as performance capacity. Side-blotched Lizards, *Uta stansburiana*, exhibit throat color polymorphism (i.e. orange, yellow, and blue badges), which signal alternative life history strategies to conspecifics. Although morphological, behavioral and physiological characteristics have been shown to differ across male morphs, color variation within each morph has not been compared to aspects of individual quality. In wild-caught adult male *U. stansburiana*, we tested for associations between coloration (colorimetrics and size of throat badge and side-blotch), a range of morphological traits (snout-vent length, mass, limb and head measures), and performance capacity (sprint speed). Across morphs, sprint speed is positively correlated with aspects of coloration including throat badge and side-blotch size. Sprint speed is also positively correlated with mass, but not snout-vent length and hind limb length. Within morphs, blue hue, yellow brightness, and orange saturation are positively correlated with sprint speed, while other colorimetric relationships are not significant. Our results reveal sexual coloration in male *U. stansburiana* to be indicative of performance capacity, which may be used as competitive signals under sexual selection.

Introduction

In many species, including birds and reptiles, coloration expressed in dimorphic species is suggested to have evolved in response to male-male competition and female mate choice.¹

Honest signal theory predicts that animal coloration can evolve by sexual selection if variation in the trait accurately reflects the relative quality of individuals expressing the trait.²

Traits related to whole animal performance capacity can affect outcomes of sexual selection as they are related to competitive ability and thus individual quality.³

Since performance traits contribute to individual quality, they may be indicated by aspects of coloration.

Side-blotched Lizards, *Uta stansburiana*, exhibit throat color polymorphism (i.e. orange, yellow, blue), which signal differences in morphology, physiology and behavior (Fig. 1).⁴⁻⁵

The purpose of this study was to determine possible relationships between color variation and performance capacity across and within morphs of Side-blotched Lizards.

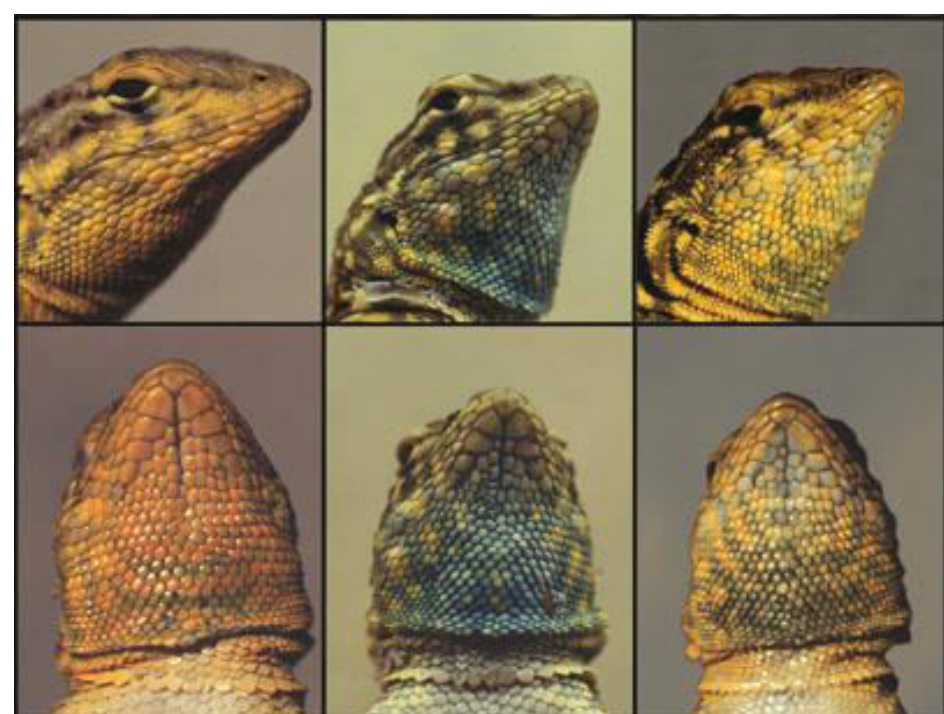


Figure 1. Throat color polymorphism of male Side-blotched Lizards *U. stansburiana*.⁴

Hypothesis

We hypothesized that components of coloration within and among morphs of male Side-blotched Lizards are indicators of performance and could serve as honest signals for sexual selection.

Methods & Materials

Field Capture and Measurements

- 50 male Side-blotched Lizards were collected via noosing during May 2017 in St. George, UT, USA.
- Sex, age, and morph was recorded upon capture
- Body mass was measured using a digital scale, and snout-vent length and limb length were measured using a metric ruler.
- Digital photographs of individual throats were collected upon each capture and used to measure badge size.

Throat Coloration Measurements

- Individuals photographed with ColorChecker Passport.
- Raw image files calibrated in Adobe Lightroom.
- Average RGB color values and badge size were calculated in Adobe Photoshop.

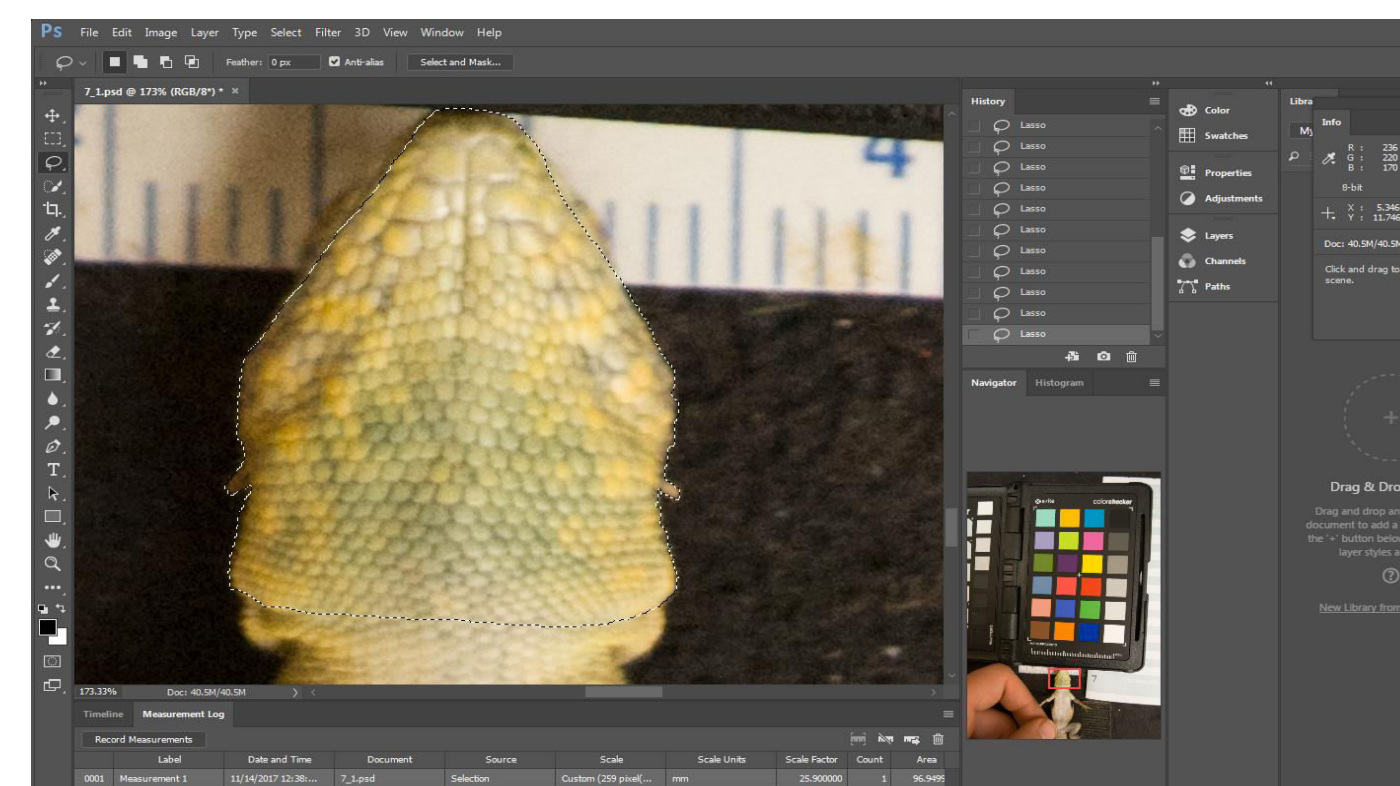


Figure 2. Adobe Photoshop interface used to analyze aspects of coloration.

Performance Analysis

- Lizards were raced on a 2-meter track to determine average sprint speed (m/s).

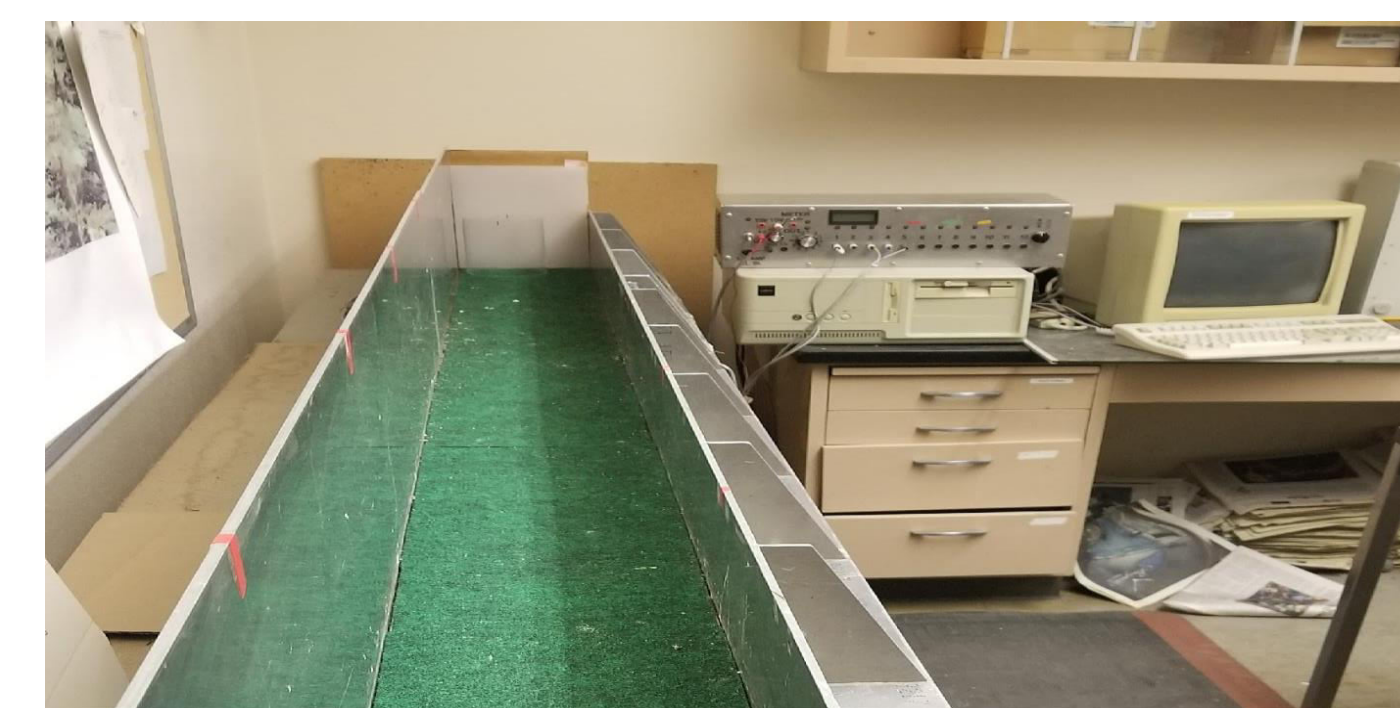


Figure 3. A 2-meter racetrack equipped with infrared sensors.

Statistics - Multiple Regression

- (n = 50 lizards; 13 OB, 16 OO, 11 YB, 10 YY)
- (p < 0.05) = statistically significant

Dependent Variables:

- Sprint Speed

Independent Variables:

- Badge Size
- Mass
- Snout-Vent Length
- Hind Limb Length
- Hue
- Saturation
- Brightness

Results

- Sprint speed is significantly, positively related to throat badge size (Fig. 4; $p = 0.017$, $r^2 = 0.148$) and side-blotch size ($p = 0.044$, $r^2 = 0.07$).
- Sprint speed is significantly, positively related to mass (Fig. 5; $p = 0.024$, $r^2 = 0.102$), but not related to snout-vent length ($p = 0.129$, $r^2 = 0.027$) or hind limb length ($p = 0.252$, $r^2 = 0.02$).
- Within morphs, sprint speed is significantly, positively correlated with yellow brightness ($p = 0.011$, $r^2 = 0.186$), orange saturation ($p = 0.043$, $r^2 = 0.096$), and significantly negatively correlated with blue hue (Table 1; $p = 0.0002$, $r^2 = .356$), while other colorimetric relationships are not significant ($p > .05$).

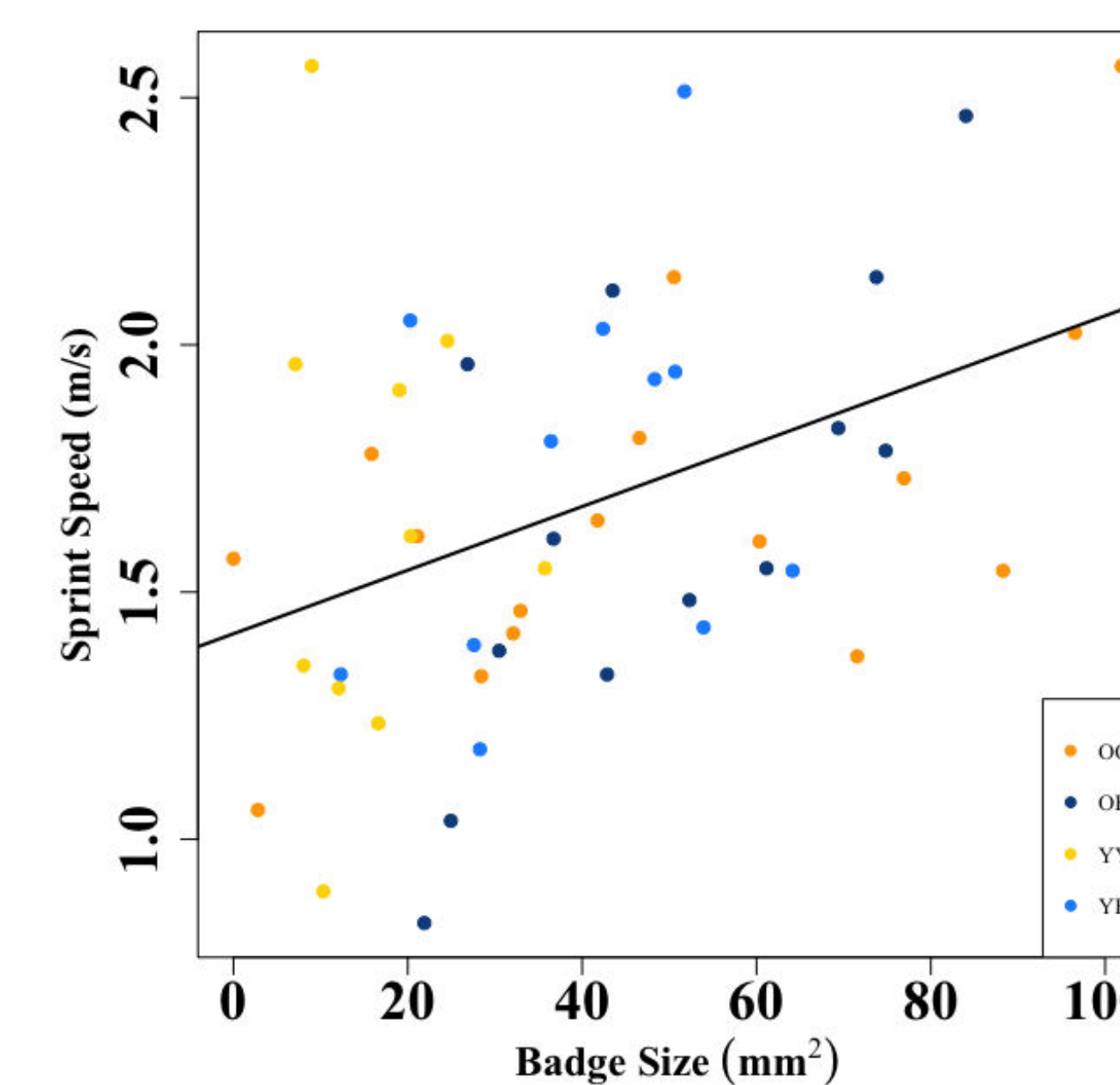


Figure 4. Sprint speeds of male Side-blotched Lizards with respect to their overall throat badge size ($p = 0.017$, $r^2 = 0.148$).

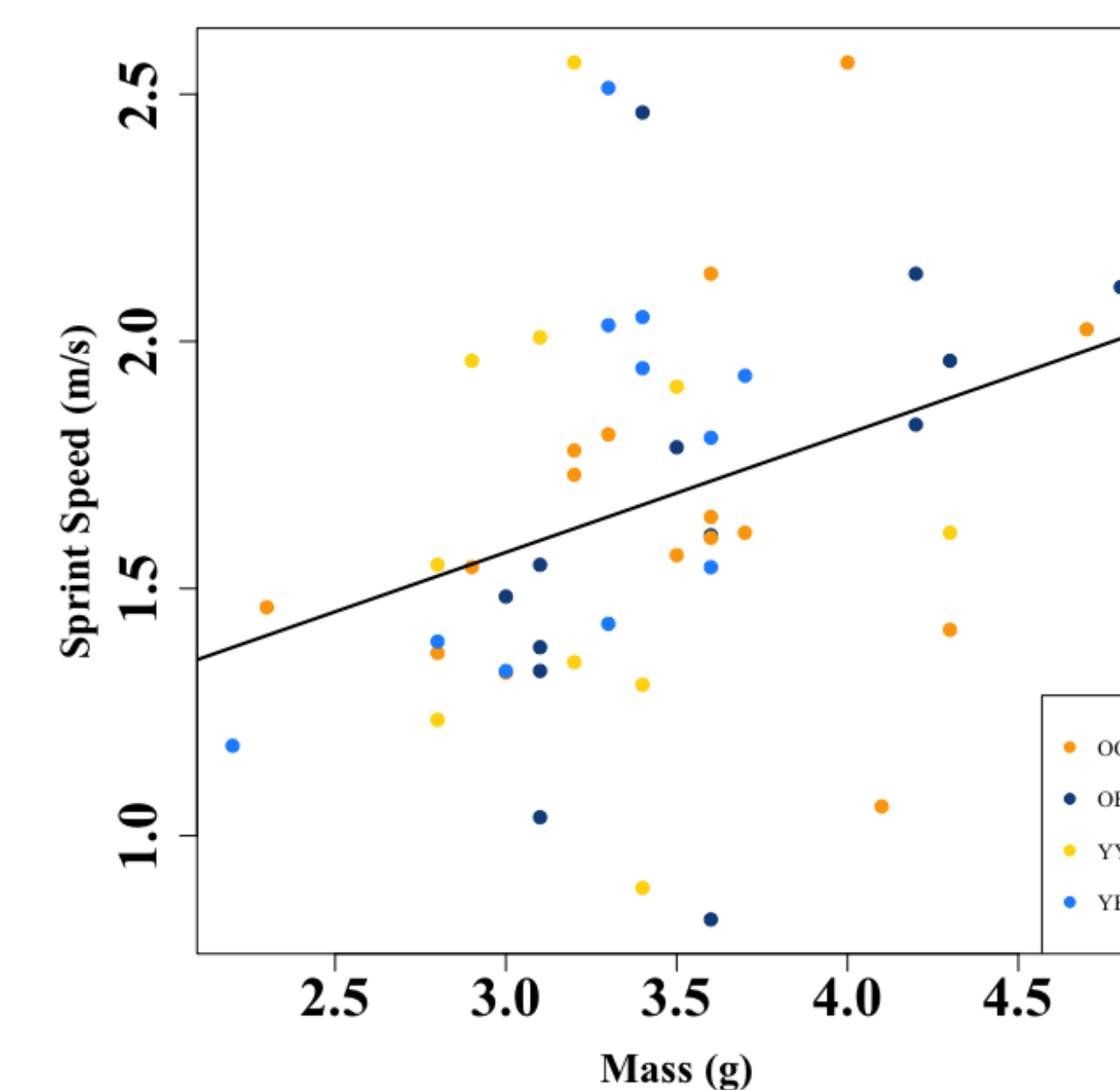


Figure 5. Sprint speeds of male Side-blotched Lizards with respect to their mass ($p = 0.024$, $r^2 = 0.102$).

Table 1. Multiple linear regression of sprint speeds and throat badge colorimetrics of male Side-blotched Lizards. Each column contains the p-values for each morph analysis.

	Blue Morph Sprint Speed (m/s)	Orange Morph Sprint Speed (m/s)	Yellow Morph Sprint Speed (m/s)
Hue	0.00002	0.5921	0.2066
Saturation	0.233	0.043	0.467
Brightness	0.941	0.3927	0.011

Discussion

- Our hypothesis that sexual characteristics in male Side-blotched Lizards can serve as indicators of performance was partially supported.
- Sprint speed is correlated with some important dimorphic traits including mass, throat badge and side-blotch size across morphs and throat colorimetrics within morphs (blue hue, orange saturation, and yellow brightness).
- However, other aspects of morphology and coloration yielded no significant relationships with sprint speed.
- These results generally suggest that Side-blotched Lizards able invest more into sexual characteristics also have faster sprint speeds and thus greater performance capacity.
- Each morph may utilize variable aspects of sexual coloration to serve as a multicomponent signal of individual performance capacity.
- Although sexual coloration has frequently been found to indicate important quality measures in lizards, relationships with whole-animal performance remain largely unexplored.
- Recent findings reveal melanin-based coloration indicates bite-force and sprint speed in male Common Lizards (*Zootoca vivipara*).⁶
- In contrast, sprint speed is not related to sexual color variation in male Wall Lizards (*Podarcis muralis*),⁷ nor to bite-force in male Western Canaries Lizards (*Gallotia galloti*).⁸

Literature Cited

- [1] Darwin, C.R. (1871). The descent of man, and selection in relation to sex. Murray, London.
- [2] Zahavi, A. (1975). Mate selection – a selection for a handicap. *J. Theor Biol.*, 53: 205-214.
- [3] Husak, J. F., Fox, S. F., Lovern, M. B., & Van Den Bussche, R. A. (2006). Faster lizards sire more offspring: sexual selection on whole-animal performance. *Evolution*, 60(10), 2122-2130.
- [4] Sinervo, B., & Lively, C. M. (1996). The rock-paper-scissors game and the evolution of alternative male strategies. *Nature*, 380(6571), 240-243.
- [5] Sinervo, B., Miles, D. B., Frankino, W. A., Klukowski, M., & DeNardo, D. F. (2000). Testosterone, endurance, and Darwinian fitness: natural and sexual selection on the physiological bases of alternative male behaviors in side-blotched lizards. *Hormones and Behavior*, 38(4), 222-233.
- [6] San-Jose, L. M., Huyghe, K., Schuerch, J., & Fitze, P. S. (2017). More melanized males bite stronger but run slower: potential performance trade-offs related to melanin-based coloration. *Biological Journal of the Linnean Society*, blix045.
- [7] Zajitschek, S. R., Zajitschek, F., Miles, D. B., & Clobert, J. (2012). The effect of coloration and temperature on sprint performance in male and female wall lizards. *Biological Journal of the Linnean Society*, 107(3), 573-582.
- [8] Huyghe, K., Vanhooydonck, B., Scheers, H., Molina-Borja, M., & Van Damme, R. (2005). Morphology, performance and fighting capacity in male lizards, *Gallotia galloti*. *Functional Ecology*, 19(5), 800-807.

Acknowledgments

We would like to thank National Science Foundation for their funding and support with lab expenses, as well as the Utah State University Ecology Center for travel funding. We also thank Holly Flann for her assistance with performance trials