

SEASONAL PHENOTYPIC VARIATION IN THE AEOLIAN WALL LIZARD, *PODARCIS RAFFONEI*, OF THE CAPO GROSSO (VULCANO) POPULATION



GAMBIOLI B.¹, PISCHEDDA A.¹, PARDO C.¹, CARUSO Y.¹, MACALE D.², VIGNOLI L.¹

¹ Dipartimento di Scienze, Università Roma Tre, Viale G. Marconi 446, 00146, Rome, Italy.

² Fondazione Bioparco di Roma, viale del Giardino Zoologico 1, 00192, Rome, Italy.



Introduction

Mediterranean lizards change color in relation to geographic variation, elevation and environmental modifications that occur between seasons^{1,2,3}. We aim to assess whether seasonal color variation also occurs in the critically endangered Aeolian wall lizard *Podarcis raffonei* (Mertens, 1952), that survives on just three islets of the Aeolian archipelago and on Vulcano island. On the latter, it has recently disappeared from the areas where it had been originally described⁴ and is now confined to the Capo Grosso promontory. Vulcano also hosts the invasive Italian wall lizard *P. siculus* (Rafinesque-Schmaltz, 1810), hybrids between the two species were observed and showed an intermediate greenish phenotype.



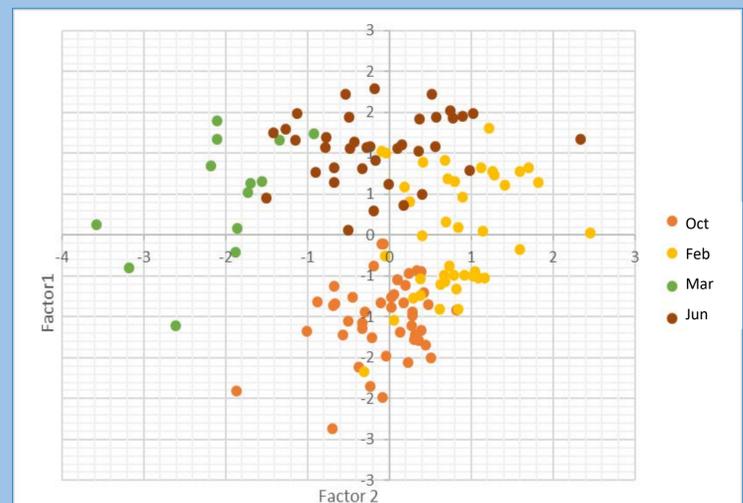
Methods

Podarcis raffonei individuals (n=46) were collected in May 2017, at the Capo Grosso area in the island of Vulcano for an ex-situ conservation project headed by the Department of Sciences – Roma Tre University and the Fondazione Bioparco di Roma. The lizards, all adults, were sexed and measured for the snout-vent-length (SVL, mm).

Photographic sessions were carried out in October 2017, February 2018, June 2018 and March 2021. Photographs of the dorsal pattern were taken under standard conditions⁵ and the RGB color values and HSB measurements were retrieved once the black spots had been excluded.

To quantify the seasonal color variation in *P. raffonei*:

1. A Principal Components Analysis (PCA) was run with all the color variables
2. A GLM was carried out with the PC1 as the dependent variable, time and sex as independent variables and SVL as a covariate.
3. An ANOVA was run with just the green color channel as the dependent variable, and again time and sex as factors.



Graph1. Scatter plot of PC1 on PC2, divided per month.

Results

The R, G, B, and Brightness contributed to PC1, which explained 64% of the variance in the dataset (eigenvalue=3.88), with the total explained variance by the first two factors of 88%.

The coefficients relating the PC1 to the original variables were all positive, therefore a lower PC1 represents an overall darker color (Graph 1). The GLM revealed that the individuals' overall color differed from one time period to another, and while the SVL and sex had no effect, the relation between sex and time turned out a reliable predictor.

A post-hoc Turkey HSD test was performed to assess which time period was significantly different and it showed that only October and June did not differ. The Green value was also only affected by time (F=39.29, df=3, p<0.001), and again the post-hoc Turkey HSD test showed that October and June represented a homogenous group.

Univariate Tests of Significance for Factor 1					
Sigma-restricted parameterization – Effective hypothesis decomposition; Std. Error of Estimate; 5637675					
	SS	Degr. of Freedom	MS	F	p
Intercept	0,004	1	0,004	0,012	0,911
sex	1,1745	1	1,175	3,446	0,066
TIME	66,756	3	22,252	5,277	<0,001
SVL	0,075	1	0,075	0,221	0,639
sex*TIME	9,984	3	3,328	9,763	<0,001
Error	43,974	129	0,341		



Conclusions

Like other *Podarcis* species^{2,3}, the Aeolian wall lizard shows plasticity in its dorsal coloration, which varies across the year. This variation does not depend on sex nor the size of the lizards and might increase their crypsis, decreasing the probability of being detected and preyed upon⁶. To evaluate whether this shift in pigmentation is a response to the change in their environment, a background color matching analysis has been started in 2021 to consider the effect of different substrates used for basking throughout the year on the Vulcano island. Moreover, the observed variation in the dorsal color pattern across seasons and years would suggest that the phenotype should not be considered as a predictor to discriminate between pure Aeolian lizards and *P. raffonei* x *P. siculus* hybrids.

REFERENCES

1. MORENO-RUEDA, G., GONZÁLEZ-GRANDA, L.G., REGUERA, S., ZAMORA-CAMACHO, F.J., MELERO, E., 2019: Crypsis decreases with elevation in a lizard. *Diversity*, 11, 236
2. ORTEGA, J., MARTÍN, J., CROCHET, P.-A., LOPEZ, P., CLOBERT, J., 2019: Seasonal and interpopulational phenotypic variation in morphology and sexual signals of *Podarcis liolepis* lizards. *PLoS ONE* 14,3: e0211686.
3. PELLITTERI-ROSA, D., GAZZOLA, A., TODISCO, S., MASTROPASQUA, F., LIUZZI, C., 2020: Lizard colour plasticity tracks background seasonal changes. *Biol Open* 9: bio052415.
4. CAPULA, M., LO CASCIO, P., 2011: *Podarcis raffonei* (Mertens, 1952). pp. 401-407. In: Corti, C., Capula, M., Luiselli, L., Razzetti, E., Sindaco, R., (eds), *Fauna d'Italia, Reptilia*, Edizioni Calderini di Il Sole 24 ORE, Bologna.
5. STEVENS, M., PARRAGA, C.A., CUTHILL, I.C., PARTRIDGE, J.C., TROSCIANKO, T.S., 2007: Using digital photography to study animal coloration. *Biological Journal of the Linnean Society* 90, pp.211–237.
6. MERILAITA, S., SCOTT-SAMUEL, N.E., CUTHILL, I.C., 2017: How camouflage works. *Philos. Trans. R. Soc. B*, 372.