1. Record Nr. TD13028343

Autore	Beltrami, Giulia
Titolo	Meccanismi di orientamento nella lucertola campestre: bussola a polarizzazione e ruolo dell’occhio parietale [Tesi di dottorato]
Lingua di pubblicazione	Non definito
Formato	Tesi di dottorato
Livello bibliografico	Monografia
Note	In relazione con http://eprints.unife.it/372/

Sommario

My PhD research activity focused on the investigation of the role of polarized light in the directional orientation of the lacertid lizard Podarcis sicula. In particular, the aim of this work was to systematically analyze P. sicula orientation behaviour and to lay the foundation for future electrophysiological and molecular investigations of anatomical structures assigned to sky polarization perception. Another goal was to understand the evolutionary meaning of these structures and the mechanisms of polarization perception. For this purpose, the first experimental section (EXPERIMENT 1: Beltrami et al., 2010) examined whether ruin lizards P. sicula are able to orientate using the E-vector direction of polarized light. Lizard orientation was tested indoors, under an artificial light source: this device produced plane polarized light with a single E-vector, that provided an axial cue. These results showed that lizards can learn a training axis and that after 90° rotation of the E-vector direction of polarized light the lizards’ directional choices rotated correspondingly. The following step of the study aimed at elucidating whether the functioning of a sky polarization compass would be mediated by the lizard parietal eye. To test this, ruin lizards that met learning criteria were tested under polarized light after their parietal eyes were painted black. Lizards with black-painted parietal eyes were completely disoriented. These data showed for the first time that the parietal eye plays a central role in mediating the

functioning of a putative sky polarization compass of lizards. Furthermore, the experimental apparatus used in this experiment emitted light that did not include wavelengths in the UV range. Thus, the UV range is not necessary for perceiving polarized light in ruin lizards, unlike other species as, for example, honey bees and desert ants that in the absence of UV are unable to use a sky polarization compass. That being so, the second experimental part (EXPERIMENT 2) was aimed at testing whether there is a preferential region of the light spectrum to perceive the E-vector direction of polarized light. The results showed that lizards can learn a training direction when trained under white light produced by an LCD and E-vector parallel to the training axis. Lizards that met the learning criteria were then tested under white light and E-vector perpendicular to the training axis, just to validate the new LCD equipment: as expected, lizards followed a 90° rotation of the Evector direction, confirming once again that they can use the polarized light for orientation. Thereafter, lizards were tested under coloured polarized light (blue, green, red and turquoise), initially with E-vector parallel to the training axis and then with E-vector perpendicular to the training axis, to examine whether P. sicula can perceive polarized light of a particular wavelength range and use it in orientation. Under both blue light and turquoise light lizards were able to orient in both E-vector's conditions, otherwise under red light lizards were completely disoriented; under green light lizards were able to orient themselves only when the direction of the E-vector was the same as in training, whereas after a 90° rotation of the E-vector lizards were disoriented, in both spectral radiance level (high and low). Incorrect orientation after E-vector rotation under Green light was independent of (high or low) spectral radiance and one hypothesis to interpret these data is that the green stimuli could be barely discernible. These results, combined with the data under Green light previously discussed, demonstrate that the blue-turquoise part of the light spectrum is crucial for a correct functioning of sky polarization compass, whereas red wavelengths do not mediate perception of the E-vector. The third experimental section (EXPERIMENT 3) was performed outdoors. The first part of this experiment was aimed to validate the new set-up outdoors. Inside the experimental apparatus lizards had only the sky polarization pattern available for orientation. As expected, the results demonstrated that lizards can learn a training direction and the new set-up is well suited to investigate orientation mechanisms in lizards. The second part of this experiment was aimed at testing the time-compensated nature of the sky polarization compass. The results demonstrated that lizards can learn a training direction under blue sky with no sun's disc, but surprisingly, they cannot retain the spatial information. Indeed, after 6 days without training, both control group and fast-shifted group, were disorientated. A possibility is that some aspects of the information necessary for the normal functioning of the sky polarization compass is not retained for a week with no training. Alternatively, it is possible that the sky polarization compass needs to be recalibrated almost daily by external cues, such as exposure of the lizards to the sun's disc. Clearly, other explanations are possible, and further experiments outdoors are necessary to answer this important question. Results relating to my three year of PhD course show the way forward to new interesting questions and so to new possible experimental applications to finally clarify the evolutionary role of the sky polarization compass and its interactions with other orientation mechanisms (for example the sun compass or the magnetic compass). It should be very interesting to deepen the

	knowledge of the nature of the sky polarization pattern’s information, to elucidate the time-compensated mechanisms that set the information retention.
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