MADGASCAR DISSERTATION/THESIS PROJECT

MA52 - Colour variability and the ecological use of colour in lizards of Mahamavo

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Colour and the ability to change colour are some of the most striking features of lizards. Unlike birds and mammals that have feathers and hair that obscure the skin, in reptiles the skin is typically exposed. Lower vertebrates generally have a collection of pigment cells in the dermis that combine to produce the skin colour that is observed. Lizards and other vertebrates have also evolved a number of different mechanisms for changing colour as well.

There are several kinds of pigment cells called chromatophores in lower vertebrates that can either contain specific pigments or produce colour structurally. The colours of pigmented cells are typically limited by the absorption of specific wavelengths of light by specific pigments. The light that is not absorbed but reflected by these cells constitutes the observed colour of the cell. Structural colours are not produced by pigments but by the arrangement of organelles within the cells that produce them. These cells either scatter light or use a mechanism like thin-layer interference to amplify specific wavelengths to appear a particular colour. These chromatophores, iridophores in reptiles, can reflect different colours based on the different ultrastructural arrangment of organelles called reflecting platelets. In addition one mechanism of rapid colour change is to rapidly rearrange reflecting platelets within iridophores.

Whether chromatophores are pigmented or producing colours structurally they seldom act in isolation. Different types of chromatophores are layered within the dermis in a fairly stereotypical organization. The colours of each chromatophore in the stack combine to determine the overall colour of the tissue. A well studied example of this is seen in the green skin of *Anolis carolinensis*. A yellow pigmented xanthophore covers a blue structurally coloured iridophore and both of these cells overlay a black pigmented melanophore. The yellow and the blue combine to an observed green colour that is intensified by the absorption of stray light by the underlying melanophore. Another common mechanism of rapid colour change in lizards is the rearrangement of pigmentary organelles

so that they are in a different position within the overall chromatophore stack. The green of *Anolis carolinensis* can turn brown if the organelles contained within the melanophores move into a position where they overlay the yellow and blue of the xanthophores and iridophores respectively.
Colours and colour change are used in quite complex ways both physiologically and ecologically. The three primary roles of tissue colour in reptiles are for thermoregulation, crypticity and signaling. Darker animals would absorb more solar radiation and warm faster than lighter coloured animals. Crypticity ties in with eating or being eaten. Animals that are highly cryptic can avoid predation or conceal themselves from prey until they are in striking range. Signaling is almost the opposite of crypticity. Animals use bright colours to positively communicate social status to conspecifics; males can signal to other males to avoid fights and increase fitness and males and females can signal to one another and sexual selection can result. The apparent evolutionary contradiction between crypticity and signaling colours has been resolved in a number of different ways in different ways such that many lizards can be both cryptic and still signal conspecifics and has been of interest to evolutionary biologists for many years.

The two dissertation projects revolving around lizard colour in Madagascar for this coming summer focus on two very different groups of lizards, chameleons and nocturnal leaf-tailed geckos, that have very different approaches to the evolutionary trade-offs associated with crypticity and signaling. In both projects objective quantification of colour will be established using a field-based Ocean Optics Jaz spectrometer. This spectrometer measures the spectral reflectance from all visible wavelengths from small individual patches of skin using a standardized light source. Spectra produced can be compared to one another from different tissue colours or the spectra can be measured as colour change is occurring.

The first dissertation project involves colour variability of chameleons. Popular literature would suggest that colour and colour change in chameleons is all about background and crypticity. Studies on how chameleons are using colour have not born this notion out. The sudden and spectacular colour changes that chameleons undergo are almost always about social interactions and signaling. Chameleons can alternate between a subdued and an excited colour pattern very rapidly. In the subdued pattern that is typically exhibited the colours and patterns seen may involve bright colours but is generally quite cryptic in foliage. The excited colour pattern however is decidedly noncryptic. Some of these colours and patterns are among the most spectacular colours and patterns found in any vertebrate. In many chameleons males can trigger a colour change in other males and males can trigger a colour change in nonreceptive females (typically gravid). Some chameleon species and sometimes populations within species can vary in their ability to change colour and the colours that are found within different genders or ages of lizards. One chameleon found in large numbers near Mariarano is *Furcifer oustaleti*, Oustalet's chameleon. This is one of the largest species of chameleon in the world. Very little is known about the variation in colour and use of colour within this species. There seems to be a good deal of variation in colour and large males have several distinct "badges" that are likely involved in social signaling. Very little is know about the extent of colour change ability of either males or females. Quantification of the spectral profiles associated with these colours and colour change will be compared to that of other chameleons. In addition this data will be used to test a colour-change model based on cell type and arrangement in the Panther chameleon.

In the second dissertation project the colour and colour change of three species of *Uroplatus*, leaf-tailed geckos, will be determined. These *Uroplatus* are stunningly cryptic apparently matching both hue and pattern with the backgrounds they are found on. Our observations this past summer did suggest that these lizards are able to change colour in social interactions or perhaps to match different backgrounds as well. *Uroplatus* are not as abundant at Mariarano as chameleons, but are found in numbers sufficient for this analysis. There are three species of leaf-tailed gecko, *Uroplatus henkeli*, *Uroplatus guentheri*, and *Uroplatus ebenaui*, that differ tremendously in size and microhabitat selection. In these lizards we will be directly comparing the spectral profiles and patterns to that of the microhabitats where they were collected. In addition social interactions between males and females will be staged and different substrate and lighting conditions will be used to determine the extent of colour change ability in these three species. Very little is known about the cellular basis of tissue colour or colour change mechanisms in geckos.

These two projects explore two different ends of the ecological continuum ofcrypticity and signaling. In spite of these two systems seeming to be polar opposites there are likely cryptic elements in the chameleon that is most know for signaling and there are likely signaling elements in the geckos that are most known for crypticity. Work this past summer established that lizards are present in sufficient number for both of these projects and that the Jaz spectrophotometer can be used to objectively quantify the colours and colour changes that are occurring.

Suggested Reading:

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