A LOOK AT LIGHT

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FOR several years I have had an interest in the various types of lighting and it's uses in vivarium design. Nowadays we are spoilt for choice; open any current commercial herptile magazine and numerous adverts extolling the virtues of a particular light seem to be present on every other page. It seemed to be a suitable time to review our knowledge of light and to discuss the possible benefits of the lighting systems currently available.

Firstly, however, we must try and understand some basic physics. It should be remembered that the light which reaches the Earth is our ultimate source of energy. The light particles or photons, when they strike certain types of matter, are capable of sending electrons into higher energy levels. This brief period of time powers the process of photosynthesis in plants, the mechanism by which simple chemical substances are formed into complex organic molecules used for metabolism. Light is not only involved in this process, however, but is also an important factor which limits, controls and orientates animal processes.

Light can be characterised in two very different ways, with modern theories of quantum physics accepting that light has properties associated with particles while on the other hand it also exhibits wave-like properties. Each of these concepts can be used in certain contexts and precise quantitative relationships between them can be calculated.

There is an enormous range of electromagnetic spectrum which falls onto the Earth, from gamma rays up to radio waves. As herpetologists or herpetoculturists we tend to think only about the narrow band which we call light; this ranges in wavelength from approximately 380 nm to 760 nm. The significance of this is that it causes an effect on the retina of the human eye — we can 'see' these wavelengths. We should not however confine our attention to this particular band. Wavelengths of 300 nm to 350 nm seem to have significant effects on many amphibian and reptile species, several important photobiological processes being controlled by these.

The ultraviolet wavelengths are limited by the ozone layer which surrounds the Earth in its upper atmosphere, which cuts off the wavelengths below 300 nm. The use of lamps producing wavelengths below this figure may have serious consequences on reptiles kept in captivity in close proximity to these levels of radiation. It is now well documented that wavelengths below 300 nm will damage the delicate bonds which hold together proteins and, in particular nucleic acids; this action will result in the living cells of the organism being destroyed. In fact some forms of biological sterilisation utilise powerful U.V.C. wavelength lamps to destroy micro-organisms. The low-level U.V. wavelengths may also damage molecules by displacing electrons. However, other U.V. wavelengths bring about the activation of molecules by photochemical processes.

As humans we are well aware of the effect known as sunburn. This is due to the action of U.V. wavelengths acting on the skin. Many herptiles however seem to enjoy the effects of these wavelengths and in some species exposure to high levels appears to be a necessity. The function of U.V. light in this respect is known as photodynamic action and in some cases can cause death in certain invertebrates. It is thought that the damage is caused by proteins being oxidised, which releases toxic by-products which then damage cells. Reptiles are protected from this damage by the scales affording increased screening and therefore cutting off the U.V. from the actively dividing layers of the epidermis. It is quite interesting to note that glass used in windows and vivarium design will also significantly reduce wavelengths below 320 nm. This figure is also significant in that the wavelengths below this are responsible for the production of vitamin D3, which is an important vitamin in the formation of bones and the utilisation of calcium in the diet. Wavelengths below 320 nm are responsible for the photochemical production of the vitamin from sterols. It is possible, however, to administer this vitamin in the diet by providing a suitable quantity of supplement dusted onto the captive animal's food supply.

It is interesting to note that in humans diet is perhaps more important than the quantity of sunlight — there is no question, however, of the importance of vitamin D during growth, and of the limited amount of effective sunlight for this purpose in some regions of the Earth. Rickets may he almost unknown among Eskimos who are at the greatest disadvantage as far as sunlight is concerned. We are still in an area where the answers are unknown. Lighting vivariums is still very much a hit or miss affair, but what we do know with some degree of certainty is that D3 cannot be synthesised in the body without U.V. light, and that D3 is essential for the absorption of calcium. So we can say that it is likely that most diurnal herptiles will benefit from a quantity of U.V. waves and that they are an important factor in any artificial lighting system, and possibly essential for long term success.

An interesting area of research amongst avian breeders has shown that U.V. deficiencies amongst parrots produces an excess of cock birds from the offspring, but when U.V. output from the breeder's lighting systems were boosted to more natural levels, a more normal 50:50 hen/cock ratio was restored. No scientific theories have been put forward as to the possible reasons for this, nor is it conclusive that a valid cause/effect relationship exists, but the consistency of the reports (with always a surplus of males) indicates that some statistical correlation probably exists.

Within this article most emphasis has been placed upon the U.V.'s relationship to the metabolism of calcium. Light has other beneficial actions which may be as important or perhaps even more so. All living things are strongly rhythmical, the rhythms can change or disappear unless reinforced or corrected by environmental change. Light is a very strong influence in the regulation of these cycles, with it's persistent and constant differences from day to night and summer to winter. As herpetologists we work with many different species and a fundamental problem is understanding the needs of each individual. Each species will have a spectral exposure cycle that is of greatest benefit to that species, and, as we stand currently, these are unknown. More research is needed to provide the answers.

Circadian rhythms indicate activity around a period of time relating to approximately 1 day. Research has shown that in many animals the activity rhythms are short of 24 hours and may vary with temperature. They can also be altered by light exposure. My pair of Green Iguanas show this form of behaviour in an easy to observe manner; on most days they climb to their 'sleeping shelf' just prior to the time-switch cutting off the lights and plunging the vivarium into darkness, following which they quickly fall into a deep sleep. If the time-switch is adjusted to vary the photoperiod the rhythm is disrupted for a few days before being corrected by the environmental change. Here we have a diurnal light cycle that has imposed an activity rhythm on the iguanas. The response to light and it's changing values has significant effects on a cycle which can take full advantage of changing seasonal conditions. This effect, known as photoperiodism, is a response to seasonal timing, which as well as light can be influenced and affected by temperature, rainfall, availability of food and other environmental cues.

It is thought that the mechanism which controls this biological clock is photosensitive pigments, and that it does not necessarily involve the normal visual receptors. Many species of lizards have an easily identifiable third 'eye' known as the parietal gland which can be seen on top of the skull. It is thought that this is involved in photoreceptive activities, with the dorsum of the brain acting as a probable photoperiodicity site. One type of compound which is widespread and may act as a pigment used in this process is the pterins, the absorption range occurs between 340 nm and 370 nm, and so it may be necessary to have wavelengths within this range to activate the photosensitive pigments involved in the control of photoperiodic responses.

It has been put forward that the formation of gametes (sex cells) are controlled by this process and a large amount of research has shown that sexual maturation in domestic fowl is controlled by photoperiodic cycles. It thus seems likely that this is also a factor in the production of viable gametes in herptiles.

With an increasing number of companies offering lighting systems for vivariums the herpetologist is spoilt for choice. Prices for full spectrum tubes are much cheaper nowadays and bargains can be obtained by contacting lighting wholesalers. In an article of this length it is difficult to give advice on lighting systems for individual species, although my own set-ups have used several types of lamps which have both given good results in the past. I used Thorn EMI Artificial Daylight tubes for many years. These have a similar output to Durolite Tru-lite but are approximately one third of the price. For tubes producing greater quantities of U.V. I have used Philips Actinic 09 but eventually changed to Actinic 05; the latter has a good output at the 310-340 nm wavelength but it is quite dangerous to human eyes. These tubes should only be used with lizards that have a high requirement for sunlight, for example Bearded Dragons, *Uromastyx* spp. and iguanas. One disadvantage of U.V.-producing tubes is that, although they have a long life, they must be replaced annually, with some dealers recommending every six months as the U.V. output deteriorates more rapidly than the rest of the spectrum. The replacement of what appears to be perfectly good fluorescent tubes annually by costly new versions is a disagreeable chore, and if you possess an extensive collection lit by large numbers of full spectrum tubes it is a major investment. Other full spectrum tubes which may be considered apart from Artificial Daylight are G.E. Chroma 50 and Westinghouse Colourtone 50. The major lighting manufacturers are now producing a bewildering array of specialist tubes with added U.V.B. levels of light. One of the most popular with experienced reptile keepers is the Reptisun 5.0; this produces adequate quantities of U.V.B. for most diurnal species and is available at a competitive price.

There are many well documented cases where owners have taken normally docile animals outside and exposed them to natural sunlight. The exposure has radically changed the behaviour from a gentle, docile individual to an aggressive and dangerous specimen. This type of change seems particularly prevalent amongst large Green Iguanas although I have heard of large Burmese Pythons acting in a similar manner. We must remember that the animals in our care are not domesticated creatures; they are wild animals and the effect of natural sunlight on many species which are normally confined to captive indoor conditions may well bring about changes in character and increased responses to a variety of stimuli.

Lighting and it's effect on herptile behaviour is a complex field and an important part of long-term husbandry and breeding. The various mechanisms we have used to successfully keep different species need to be researched and thoroughly documented, as do procedures which have been less successful. It is time for us to devote some of our resources and energies into solving the problems and challenges associated with keeping these magnificent animals, with which many of us so enjoy sharing our lives.