Iguanas and Artificial Ultraviolet Light: How and How Much Made Simple — Well, Not Exactly Simple...

* Iguanas and Artificial Ultraviolet Light: How and How Much Made Simple — Well, Not Exactly Simple...

This article was originally published in the International Iguana Societies magazine “Iguana” and was edited by Dr. Robert Powell and A.J. Gutmann (Volume 10, No3 September 2003) and later published in the Upstate Herpetological Association news letter Volume#15, issue#5 “HerpBeat” .

Dr. William Gehrmann and Dominick P. Giorgianni kindly reedited the paragraph concerning the biological process of D3 conversion (his editing is in bold print). It has again taken another reediting to reflect the latest research by Dr Gehrmann and his associates published in the Journal of Herpetological Medicine and Surgery Volume 13, No.2, 2003.

Bob MacCargar

Readers will recognize that, in order to stay healthy, iguanas require UV-B (ultraviolet radiation in the “B” range) as much as they need the complex salads we prepare for them daily. Without UV-B, the all-important mineral, calcium, cannot be effectively absorbed — and calcium is as critical as nutritious food, water, and heat. In responsible husbandry, we must replicate the UV spectrum required for the photochemical process involved in metabolizing vitamin D3 (which mediates calcium absorption) — while never forgetting that this will be of little importance if the diet, heat, etc. are less than optimal. Also remember that this is a discussion on what is best for reptiles, NOT humans. We have deliberately excluded highly technical terms to keep the reading enjoyable.

UV-B is part of the electromagnetic spectrum. This spectrum includes everything from radio waves at one end to gamma rays on the other. All of the EMS is called “radiation”. Visible light is somewhere in the middle. Wavelengths are read in nanometers from 0.001 nm (x-rays) to 100 billion nm (radio waves). A reptile bulb can be subjected to testing by an ultraviolet radiometer and spectrographs in order to measure precisely the wavelengths that are being produced. There are no longer unknowns in the electromagnetic spectrum.

The UV range is from 100-400 nm, the B range specifically from 280-320 nm. However, we are most concerned with readings from 290-300 nm. This is the D-UV range. Why? Because this is the prime range that triggers the miracle of photo-biosynthesis, creating pre-vitamin D3 from pro-vitD3 (called 7-DHC or 7-dehydrocholesterol). We think that about 80% of this photochemical reaction is triggered by ultraviolet waves in this range. Ingested pro vitD3 in the reptile's skin absorbs the UV-B wavelengths, which allows the photochemical reaction that converts the 7-DHC to pre- vitD3, which is then thermally isomerized to cholecalciferol (vitD3). The latter is then converted in the liver to 25-

hydroxycholecalciferol (25-OHvit D3) and the final step towards becoming biologically active vitamin D3 (1,25- dihydroxycholecalciferol (1,25 (OH)2 vitD3 or 1,25 DHCC) takes place in the kidneys through this process. Evidence indicates that 1,25 (OH)2 Vitamin D3 is NOT stored but is synthesized as "necessary" from the main storage form in the BLOOD, 25 OH vit D3,(therefore, the higher the blood hydroxyl level (OH25), the greater the storage capacity) and its primary function is to regulate calcium metabolism. This gives you some idea of why reptiles suffering from metabolic bone disease (the lack of sufficient D3 to metabolize calcium) may also suffer from forms of liver and kidney disease." (Although this may not be as straight forward as it appears,) W.G.

Having mentioned reptilian skin, let's quickly consider the amount of exposure of an animal to natural sunlight is necessary for this chemical reaction to take place. The assumption that a few minutes a day is sufficient is based entirely on studies with humans. Keep in mind that the electromagnetic wave lengths (photons) from the UV radiation have to penetrate the skin deep enough to reach the capillaries underneath the skin in order to produce this reaction. Anyone with experience around iguanas can appreciate how tough and thick their hide is. Several hours a day of natural sun exposure is much more appropriate for these large reptiles. (Many different species of reptiles have diverse degrees of UVB sensitivity and require different amounts of UVR in variable lengths of time.)

However, its not just UVB, the ultraviolet we need to supply for our animals must be "useable" UVB, in other words, in the "D-UV" range. How can we measure and be confident that we have supplied our creatures with ample amounts of D-UV? By far the most reliable method is to test specifically for blood levels of 25-HDCC (wild iguanas have levels of 175–275 nmol/L of this form of D3 in their blood). This test can be performed with the help of a qualified veterinarian (see reference below) and is the final say on whether we have provided optimum husbandry for our iguanas. This is much more reliable than using a standard blood panel test (which measures only calcium and phosphorus levels that can and are very deceiving). Even iguanas that have what appear to be good blood panels have been found to be on the low end of the active 25-HDCC level. This helps to explain why iguanas in the wild can drop 20 ft out of a tree and hit the ground running, whereas stories of captive Green Iguanas falling 5 ft and ending up with compound fractures are common.

Just what kind of ultraviolet levels are these creatures exposed to in their natural environment? The standard for measuring intensity of the UV spectrum is read in microwatts per square centimeter (µW/cm2). The USDA recently did a study with an Ultraviolet Pyranometer and found readings of UV-B in Florida on June 1st that reached 450 µW/cm2 (remember, however, that only a certain percentage of this falls into our "usable" D-UV). Hobbyists have the ability to take their own UV-B readings with a simple hand-held ultraviolet radiometer from Solarmeter (model 6.2). The measurements taken by the USDA are extremely close to the readings that I have been taking for the last 4 years in a study of reptile lamps and I have used this as a constant for meter calibration.

Although iguanas may not be exposed to as much as 450 µW/cm2 on a continuous basis, they will spend several hours a day exposed to relatively high numbers, generally in 150-250 microwatt range. My studies, as well as those of others, have found that, even in the “deep” shade, global UV-B readings reach 30–50 µW/cm2, but the readings are as high as 250µW/cm2 (in the shade). These numbers give us an idea of the minimum and maximum ultraviolet B exposure levels in nature.

Interestingly, another study has proven that D3 biosynthesis is a naturally self-limiting process. Without getting too technical, this “safety valve” ensures that toxic levels of vitamin D3 are not created, and that the excess is broken back down into inert ingredients (but please see the references at the end of this article). Basically this means that as long as we do not expose our iguanas to any more UV than that to which they are exposed in their natural environment, we will stay within safe perimeters. Also it has been shown that reptiles will regulate the exposure to UV to fulfill the need of D3 biosynthesis. It is important that reptiles in general have the ability to remove them selves from the UV source as well as heat to complete this process of self regulation.

Two styles of reptile UV-B bulbs are available. One is the fluorescent tube and the other is the mercury vapor (MV) reptile lamp. Both style lamps use the heavy metal mercury as a catalyst for producing ultraviolet radiation. An electrical charge passing through liquid mercury excites the molecules until they vaporize (when the mercury cools, it resumes liquid form). In the fluorescent tube the mercury is iodized and emits UV light. This energy is then absorbed by the thin coating of white phosphor on the inside of the tube. The white phosphor uses the energy to emit visible light, or “fluoresces”.

Over the past four years, I have studied failure and decay rates of mercury vapor lamps and conducted a general study of the major brand fluorescent tube reptile bulbs. I am constantly asked if I have tested a certain fluorescent brand bulb by individuals who have seen them listed inexpensively — in spite of the fact that, for many years, I have been telling people that quality UV is not cheap (unless we’re talking about the great and wondrous sun). In a recent conversation with Voltarc Technologies, one of the largest manufacturers of reptile fluorescent bulbs in the nation, the engineers confirmed the fact that money buys UV.

Production costs rise with more exacting specifications (how much UV-B and where precisely it is to be delivered). In order to build a tube that will provide not only high UV-B readings, but one that will generate output in the useable 290–300 nm range, manufacturing tolerances have to be very precise. Two different fluorescent tubes can emit equal amounts of total UV-B, yet one will do a much better job keeping your pet healthy than the other (even though both bulbs might have been manufactured by the same company, but for two different distributors’ specifications).

The best florescent tubes tested emit 12–15 µW/cm2 at 12” after initial burning. Varieties of good fluorescents (as well as some absolutely terrible ones) are on the market, but ZooMed 5.0 is built to the most exacting tolerances according to all of the manufacturers with whom I have spoken. It should be noted that research has shown that using good reflectors behind fluorescent tubes can up to double the UVR iridescence. Through the work of the Yahoo Meters group, we are finding there are other florescent tubes stepping up the plate in respectable UVB production.

The other choice in artificial UV is the mercury vapor reptile lamp, which comes in a variety of styles and wattages. Anyone who has been involved with rehabilitation work and has used MV lamps, has seen the effects of these bulbs compared to even the best fluorescent tubes. Why is this the case? Do they emit huge amounts of UV? Are they reliable? Is one brand better than another?

Most self-ballasted (SB) MV lamps suffer from a 50% decay rate over the first month and a 70%-80% decay rate in total UV-B emitted during its life (Westron’s new MV lamps have decreased these percentages to 30-50% total decay). One of the best-selling style MV bulb (ZooMed), the 160 watt FLOOD, emits much less UV-B than stated on their endorsements after decay. These bulbs settle in at about 12-15 µW/cm2 at 12". Why, then, do we see such incredible results with MV lamps when compared to fluorescents? After all, two high-quality fluorescents will produce 25–30 µW/cm2 at 12". The answer is simple: MV lamps emit less total UV-B than fluorescents — but more “usable” UV. Studies have shown that MV lamps produce the same percentages of D-UV (and UV-A, which is another subject) as a percent of total energy emitted as the sun.

Self-ballasted SPOT-style lamps produced much higher UV readings than any other reptile bulb on the market until the Westron Mega-Ray Flood lamps were marketed this year. The Spot lamps still are subject to the failure and decay rates of most self-ballasted MV lamps. These lamps settle in at about 100–150 µW/cm2 (at 12"), but have a much narrower disbursements of UV-B. Dr Gehrmanns recent paper proved that the narrow spot would raise the blood hydroxyl levels to that in nature; there fore the entire animal does not need to be immersed in UVR to stay healthy. These are excellent rehabilitation bulbs for severe metabolic bone diseases (MBD). Regarding concerns that iguanas under this style of lamp will need “goggles” to prevent blindness from “excessive” UV exposure, remember the exposure levels in their natural environment. We have five iguanas that have spent 3 years exclusively under mercury vapor SPOT lamps with no negative impact on vision. However, the distance from any MV lamp to the basking area must be regulated in order to provide optimum temperatures, regardless of any distances stated by the distributor!

So, what is best for iguanas? I recommend 75-150µW/cm2 at the basking area for at least 6 hours per day (comparable to minimal natural exposures in the wild). Although, 12 hours a day of exposure will not harm them as long as they have the ability to remove themselves from the UVR when they want. The best

way to realize this number is to use an ultraviolet radiometer (such as the Solar Meter 6.2 hand-held version; see references) to measure the amount of UV-B available to your iguana.

To achieve these levels of UVB you can use 100 and 160-watt T-Rex UV Heat SPOT lamps will emit 75–150 µW/cm2 (at 12" after break-in) — as long as they burn. The Westron Lighting Mega-Ray 60-watt in-line ballast MV lamps and the Mega-Ray SB 100 and 160wt mercury vapor lamps will produce 150-300µW/cm2at 12" (The new Mega-Ray 60-watt in-line ballasted MV lamp from Westron Lighting produces excellent UV-B with very little decay and without the problem of failure, no self-ballast to fail). No other supplemental UV-B source is necessary with these lamps.

The ZooMed 5.0 fluorescent lamps are at the top of the ladder in terms of meeting these specific requirements (i.e., the best "usable" UV-B) but other tubes are now available that perform well such as Hagen 8.0 line and the Arcadia 5.0. Use at least two of these lamps with reflectors to achieve the desired exposure levels. These lamps will also need to be closer then 12" (8-10 inches) to reach the desired UVB level. Generally speaking, reptile fluorescent tubes do not have a very good light quality and some form of "full spectrum" lighting should be used in conjunction with them.

The 100- or 160-watt T-Rex FLOOD lamps* or the 160 watt ZooMed FLOOD lamp also may be used in conjunction with ZooMed 5.0 fluorescent tubes or other quality fluorescent tubes.

*T-Rex will soon be using a Mega-Ray design for their FLOOD lamps and will not need the security of additional fluorescent tubes to reach the proper UVB level.

The market is being flooded with mercury vapor lamps mostly manufactured in China as well as poor quality florescent tubes. These have preformed poorly in our tests and we do not recommend using them unless you have an ultraviolet radiometer to measure the UVB levels. Some of these lamps have had enormous and unsafe levels of UVR while others have little to no UVB. Please do not be "sold" on inexpensive pricing or fancy packaging. Please keep in mind that any lamp sold for human commercial lighting such as the VitaLite full spectrum fluorescent tube is not capable of producing enough UVR to keep iguanas or other high UVB dependent reptiles healthy.

This is an image designed to visually break down the process.

References and Resources (listed by topic)

Electromagnetic spectrum,
http://csep10.phys.utk.edu/astr162/lect/light/spectrum.html

Photochemistry and biology, http://www.photobiology.com

Ultraviolet radiometers, www.solarmeter.com

25 HDCC vitamin D Test, University of Michigan, Animal Health Diagnostic Laboratory, PO Box 30076, Lansing, MI 48909 (517-353-0621)

Vitamin D discussion, “The Merck Manual,” 17th ed., p. 35

UV-B and D3, http://home.att.net/~chameleons/zoomedUV-B.html

25 HDCC blood level study with radiograph, David Kroughoff
http://www.myiguana.com

Comparison of Two Artificial Light Sources used for Chuckwalla, Sausomalus obesus, Husbandry. Aucone, Gehrmann, Ferguson, Chen, Holick. Journal of Herpetological Medicine and Surgery
http://www.arav.org/journals/JA020656.htm

Calcium physiology, Bogoslavsky, B. Calcium Metabolism in Iguanas. Iguana Times Journal of the International Iguana Society 9:(1&2) 32-34.

Idiosyncrasies of Vitamin D Metabolism in the Green Iguana (Iguana iguana) JB Bernard, Comparative Nutrition Society Symposium, pp. 11-14

Do Panther Chameleons Bask to Regulate Endogenous Vitamin D3 Production?
Gary W. Ferguson1,*William H. Gehrmann1Kristopher B. Karsten1,†Stephen H. Hammack2
Michele McRae1Tai C. Chen3Nancy P. Lung2Michael F. Holick3

The UV range is from 180-400 nm, the B range specifically from 280-320 nm.However, we are most concerned with readings from 290 300 nm. This is the D-UV range. Why? Because this is the prime range that triggers the miracle of photo-biosynthesis, creating pre-vitamin D3 from pro vit D3 (= 7-DHC = 7-dehydrocholesterol)).We think that about 80% of this photochemical reaction is triggered by ultraviolet waves in this range. Ingested pro vitD3 (7-dehydrocholesterol or 7-DHC) in the reptile's skin absorbs the UV-B wavelengths, which allows the photochemical reaction that converts the 7-DHC to pre vitD3 which is then thermallyisomerized to cholecalcifero l(=vitD3). The

latter is then converted in the liver to 25-hydroxycholecalciferol=25OHvit D3 and the final step towards becoming biologically active vitamin D3 (1,25-dihydroxycholecalciferol = 1,25 (OH)2 vit D3 or 1,25 DHCC) takes place in the kidneys through this process. Evidence indicates that 1,25 (OH)2 Vitamin D3 is NOT stored but is synthesized as "necessary" from the main storage form in the BLOOD, 25 OH vit D3,(therefore, the higher the blood hydroxyl level (OH25), the greater the storage capacity) and its primary function is to regulate calcium metabolism. This gives you some idea of why reptiles suffering from metabolic bone disease (the lack of sufficient D3 to metabolize calcium) may also suffer from forms of liver and kidney disease." (Although this may not be as straight forward as it appears, W.G.)

* All references to brand names refer to the author’s personal experiences and are not necessarily the view of the IIS.