Reptile Lighting: A Current Perspective

I recently called a store to inquire about a lamp (lamp A) which I wanted to examine for this article. I was told that they didn't have lamp A but they did have lamp B which was far superior, especially for iguanas. After a bit more discussion it transpired that the clerk had never heard of lamp A, but he knew lamp B was better. Unfortunately, this anecdote can serve as a metaphor for the general state of affairs in selecting lamps for reptiles; a clean-cut resolution to this problem based on experimental data is not yet available.

Although various investigators have explored the effects of light on a variety of physiological processes in reptiles (see Gehrmann, 1994A for a review) it was Joe Laszlo who called the attention of the herpetocultural community to the importance of temperature (Laszlo, 1979) and light quality (Laszlo, 1969) for health and reproduction in captive reptiles. He consulted representatives in the lighting industry and found a relatively new lamp by Duro-Test Corp. with the brand name of Vita-Lite® which was a close match to natural light. The reptiles he exposed to these lamps seemed to fare better than those illuminated with cool white tubes or incandescent lamps. His brief publication in *Intemational Zoo Yearbook* quickly led to the almost universal use of Vita-Lite® which held sway until about 1990. Joe was especially interested in ultraviolet (UV) light and for a number of years until his untimely death in 1987, we collaborated with a view toward designing a reptile lamp with a greater but safe level of ultraviolet B (UVB) or midwave UV than found in Vita-Lite® and other lamps (Gehrmann, 1987). During this time in the 1980's, two students of Duane Ullrey at Michigan State University, Mary Allen (1989) and Joni Bernard (1995), began studies exploring the importance of vitamin D and UVB to the health of reptiles, with particular reference to calcium metabolism and bone formation. These studies contributed to the development of the variety of reptile lamps available today.

The purpose of this paper is to clarify some issues related to lamp selection and reptile lighting. I particularly refer to lizards, perhaps the reptile group most sensitive to lighting conditions.

What is Full-Spectrum Lighting?
The term was first applied to the Vita-Lite® lamp produced by DuroTest Corp. and was defined as any lamp that had a color-rendering index above 90, a correlated color temperature (CCT) between 5500oK and 6800oK, and a spectral power distribution (SPD) for visible and UV light similar to that of open-sky natural daylight (Note: color-rendering index refers to the ability of light to produce the "true" colors of an object as they would appear in natural light; color temperature is a measure of the distribution of colors (wavelengths) comprising the light emitted by a lamp; see Gehrmann, 1994B for further information pertaining to light characteristics).

As used today, "full-spectrum" applied to fluorescent tubes generally implies that all colors (wavelengths) of the visible spectrum at similar energy levels contribute to the emitted light; UV irradiance is no longer implicit in the definition. Tungsten filament lamps, with glass that contains neodymium, are often referred to as "full-spectrum." The light emitted from these lamps is the same as that emitted from a household tungsten bulb but with the yellow colors removed. This "brightens" the light but the SPD is considerably different from natural light and full-spectrum fluorescent light. As herpetoculturists, we want the colors of our charges shown to best advantage. However, short or long term health benefits attributable to the use of full-spectrum light have not been experimentally demonstrated.

How Important is Ultraviolet A (Blacklight)?
UV radiation is divided into UVA (longwave), UVB (midwave), and UVC (shortwave). Blacklights are a strong source of UVA. It has been demonstrated that UVA can influence agonistic, reproductive, and signaling behaviors in some species of lizards (Gehrmann, 1994A) as well as inhibit growth in female panther chameleons, *Chamaeleo pardalis* (Ferguson, et al., 1996). A UVA requirement for long-term health and reproduction of captive reptiles has not been demonstrated. However, because UVA is a component of natural light in many environments, e.g. deserts, appears to stimulate social behavior, and does seem to be nondetrimental even at high irradiances, some herpetoculturists may elect to use a blacklight in conjunction with some other visible light and/or heat emitting lamp.

Do Reptiles Need Ultraviolet B?
UVB is noted for its ability to promote the synthesis of vitamin D3 (D3) in the skin. The extent to which dietary D3 can compensate for an insufficiency of UVB-synthesized D3 remains problematic. Over the last ten years, I have raised several generations of eyed skinks, *Chalcides ocellatus*, in environments totally devoid of UVB and with D3 provided from diet. On the other hand, green iguanas, *Iguana iguana*, appear to be able to utilize UVB-synthesized D3 better than dietary D3 (Bernard, 1995). In addition, Ferguson, et al. (1996) present evidence that UVB may be more effective (than dietary D3) in promoting egg hatchability in panther chameleons (*C. pardalis*).

How Much UV and Visible Light is Emitted by Lamps Used in Herpetoculture?
Table 1 lists fifteen lamps that are available commercially to herpetoculturists. They are arranged in rank order of UVB irradiance.

Are All Wavelengths of UVB Equally Effective in Promoting Vitamin D3 Synthesis?
UVB is generally defined as the wavelength band from 290-320nm. Based on data by MacLaughlin, Anderson, and Holick (1982), I have calculated that about 60% of D3 is produced between 290-300nm. Because most D3 is synthesized within this narrow subdivision of UVB (between 290-300nm), the range has been termed D-UV (Bernard, 1995). The lamps in Table 1 use a phosphor that peaks at about 313nm. Therefore most of the UVB emitted is at wavelengths greater than 310 nm. Only about 5 % of D3 results from wavelengths greater than 310 nm.

Does This Mean the Lamps are Ineffective in Promoting Vitamin D 3 Synthesis?
Not necessarily. The effectiveness of a lamp will depend on the species, the length of exposure time, the distance to the lamp as well as dietary and thermal factors. Also, most of the lamps in Table 1 do emit some energy at the ideal D3-producing wavelengths. The only experimental studies I know of pertaining to the effectiveness of lamps for longterm health and reproduction involve chameleons, *Chamaeleo*, and are being conducted principally in Gary Ferguson's lab at Texas Christian University, with several zoos participating in some of the work.

Is There a Reptile Lamp That is Safe and Specifically Designed to Maximize Vitamin D3 Synthesis?

An experimental lamp using a special phosphor that peaks at about 296nm has been tested and been shown to be effeclive in promoting D3 synthesis and elevating blood D3 metabolites in iguanas (Bernard, 1995). Manufacturing and marketing activities are currently underway and this "Sylvania 2096 Experimental Reptile light" may be available sometime in 1997 (Bernard, personal communication).

What do the Numbers Sometimes Used to Describe Reptile Lamps Mean?
Numbers, such as 2% or 8%, or in decimal form, such as 5.0 or 2.0, refer to the percentage of total energy emitted from the lamp between 290nm and 700nm (UV and visible light) that is UVB (290-320nm). These numbers can be used to compare relative UVB emission among lamps, but can not be directly related to the irradiance or the distribution of energy at different wavelengths within the UVB band or the D3 synthesizing capability.

Can Metal Halide Lamp Systems be Used for Reptiles?
Yes. The light characteristics of a I00 watt metal halide lamp are shown in Table 1. The lamps emit substantial visible light and "respectable" amounts of UVA and UVB. However, these systems are costly (in excess of $200) and comparable quality lighting can be attained less expensively.

Will Reptiles Regulate Their Exposure to Ultraviolet Light?
Jones et al., (1996) reported that female panther chameleons, *C. pardalis*, receiving low levels of dietary D3 or preparing to oviposit will behavioraly increase their exposure to UV light, compared to controls, in a UV gradient. This exciting observation requires further exploration with respect to other species and mechanisms. The study suggests that it might be judicious to include shaded areas in vivaria receiving relatively high levels of UVB.

Is There a Component of Natural Light That May Be More Important Than Light Quality?
In a recent issue of *The Vivarium*, Gehrmann (1996) mentioned a considerable body of literature that emphasizes the importance of infrared radiation (heat) for thermoregulation. Some species, particularly nocturnal forms, may preferentially utilize heat radiated from the substrate rather than from sunlight. Diurnal basking species however receive both light and infrared radiation when they bask. Sievert (1991) has shown that spatial separation of a light and a heat source can lead to alteration of thermoregulatory behavior. While the importance of this for longterm health has not been demonstrated, I suggest that it may be desirable to use a reflector lamp as a combined heat and light source, particularly for basking species, with adjunct light sources placed where convenient.

TABLE 1
Measurements of various lamps using a Spectroline UVA radiometer, a Spectroline UVB radiometer and a General Electric Type 214 light meter. All fluorescent tubes were 20 watt, F20/T12 types and measurements were made from 30 cm (12 inches) from the sensors except where otherwise indicated. In decreasing order of UVB irradiance. (Note: The UVA and UVB in the following chart is in $\mu W/cm^2$).

Bulb	Manufacturer	UVA	UVB	Illuminance (lux)
Reptisun UVB 310	Zoo Med[1]	23	10	398
Reptile D-Light 8%	National Biolological Corp. *no longer made*	7	9	409
Reptile D-Light 3%	National Biolological Corp. *no longer made*	6	4	430
Reptile Daylight	Energy Savers Unlimited (ESU)	3	3	398
Sylvania 350 Blacklight	Sylvania	153	2.6	86
Metal Halide, 100w, 5500K	Energy Savers Unlimited (ESU)	40	1.9	2260
Vita-Lite	Duro-Test	6	1.3	452
VLX Full Spectrum	Verilux	3	1.2	490
ReptaSun	Fluker	5	1.1	538
Chroma 50	General Electric	2	1.1	495
Colortone 50	Philips Lighting Co.	2	1.1	484
Lumichrome Full Spectrum[2]	Lumiram	4	0.9	527
Ott-Lite	Environmental Lighting Concepts	2	0.9	479
Repti-Glo	Rolf C. Hagen Corp.	1	0.9	829
Cool White	Sylvania Lighting	2	0.1	527