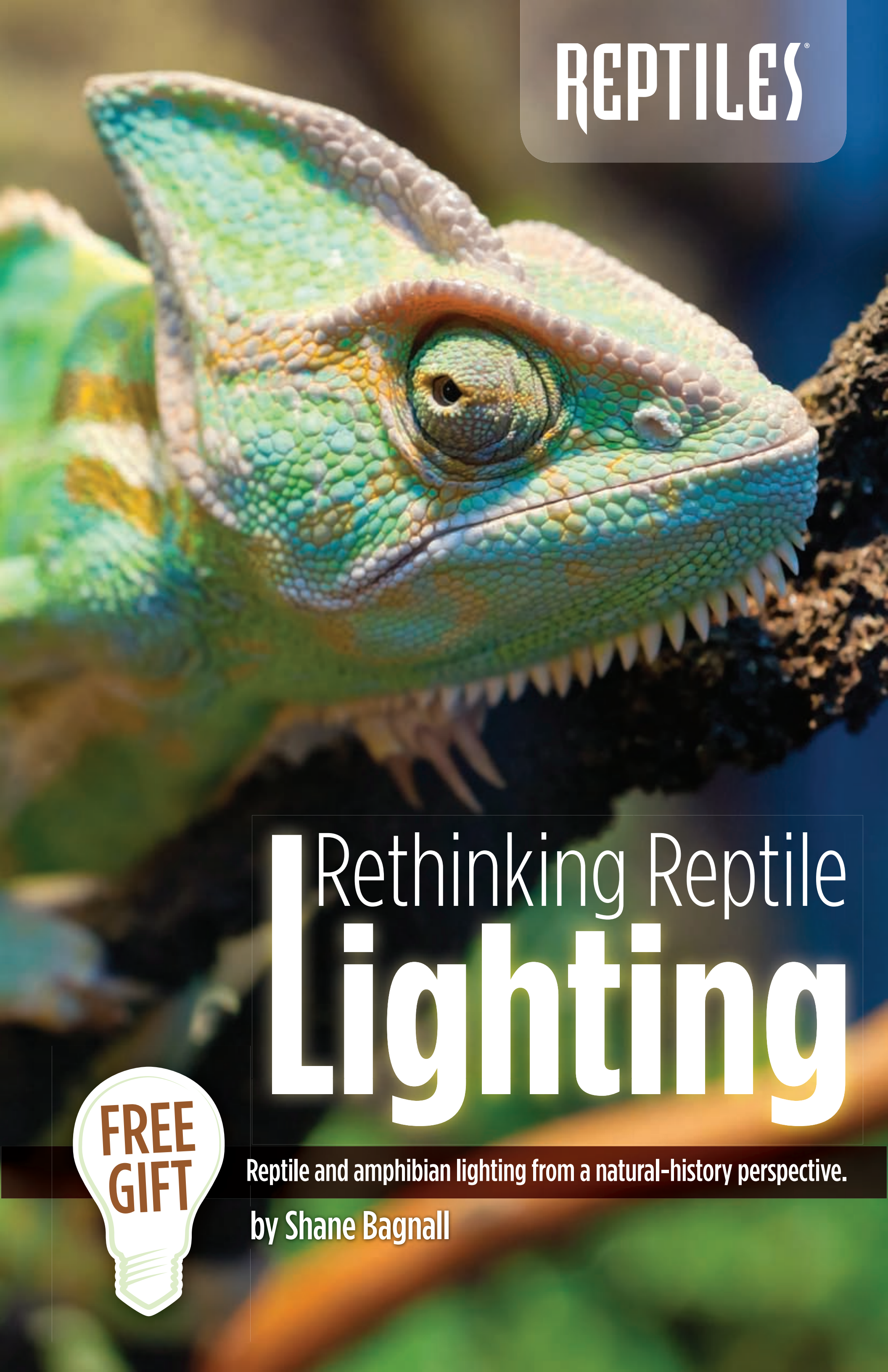


REPTILES

Rethinking Reptile Lighting

Reptile and amphibian lighting from a natural-history perspective.

by Shane Bagnall

FREE GIFT

In the early 1940s, our knowledge of the effects of light on reptiles and amphibians was very limited. It wasn't until 1944 that we learned of the amazing ability of reptiles to maintain relatively stable body temperatures through thermoregulation. This was the result of a groundbreaking study by herpetologists Raymond Cowles and Charles Bogert, who coined the terms "ectotherm" and "endotherm." Their landmark study inspired numerous research projects on the effects of light and heat on reptiles.

Since then, our knowledge of reptile lighting has increased tremendously. We now know that many reptiles and amphibians can see things illuminated by ultraviolet-A, and that they can make vitamin D in their skin upon exposure to ultraviolet-B. When housed in captivity without access to UVB, many reptiles developed a form of metabolic bone disease (MBD) that results in soft, deformed

While some geckos are diurnal, like this Madagascar giant day gecko, many nocturnal geckos become active at dusk and receive low levels of UVB before the sun sets.

Courtesy Kirby Spencer / Zoo Med Laboratories

bones and is often fatal if not corrected by UVB exposure. With this knowledge came the introduction of the first commercially available UVB lamp for reptiles in 1993, which allowed people to successfully maintain and breed a variety of reptile species in captivity. Although preventing the onset of disease is good motivation to provide adequate lighting for captive reptiles, many keepers are going to the next level in an effort to accurately recreate truly naturalistic habitats, even with respect to lighting.

Panther chameleons have been the subject of much UVB research over the years. This hatchling was bred at Zoo Med and receives UVB from an energy-efficient, compact fluorescent UVB lamp.

Courtesy Kirby Spencer / Zoo Med Laboratories

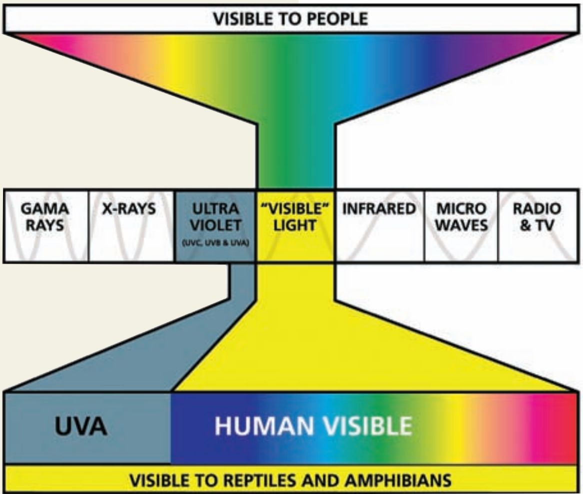
Humans see the world differently than reptiles and amphibians. Many reptiles and amphibians have the remarkable ability to see things illuminated by UV wavelengths. Also, some lizards and amphibians have a third eye on the top of their head known as the parietal eye. This eye cannot see the full complement of colors that the other two eyes see, but it can sense light and is associated with photoperiod regulation (circadian rhythms), reproductive behavior, basking behavior and thermoregulation. The parietal eye may also be sensitive to UV wavelengths (Jenison, 1980). These differences in how reptiles and humans see have caused persistent confusion on what defines full-spectrum lighting and UV lighting.

Full-Spectrum and UV Lighting

The term “light” is typically associated with vision, and because people are the ones doing the research, we have identified the visual portion of the electromagnetic spectrum according to the colors that we are able to see. Full-spectrum lighting for reptiles should have emissions in the human visible wavelengths (red

Photoherpetology

Many think of the word “photo” as referring to a picture, but the original meaning of the word is “light.” “Photograph” literally means “drawing with light.” The study of the effects of light, or photons, on living things is called photobiology. Herpetology is defined as the study of reptiles and amphibians. By combining these two terms, I propose a new word to give identity to the growing field of the study of reptile and amphibian lighting: photoherpetology.



This electromagnetic spectrum shows the difference between the vision of humans and the vision of reptiles and amphibians.

Courtesy Shane Bagnall

through violet), in addition to emissions in the UVA region of the electromagnetic spectrum. It is important to note that a full-spectrum reptile lamp may not produce UVB, unless the manufacturer specifically states so on the package.

The shorter wavelengths adjacent to the human visible wavelengths of the electromagnetic spectrum are appropriately called ultraviolet. These wavelengths are broken into three categories: UVA, UVB and UVC. As mentioned, many reptiles and amphibians can see things illuminated by UVA light, and thus UVA makes up a portion of their visible spectrum. UVB wavelengths are shorter than UVA wavelengths and may or may not be visible. Even though lamps are used to produce UVB, the term "UVB light" is a bit of a misnomer, because animals may not have the ability to see things illuminated by UVB wavelengths. UVB is associated with synthesis of vitamin D in the skin, in addition to playing a role in the immune system of animals. There is evidence that reptiles can sense UVB and will adjust their exposure based on the amount of vitamin D in their blood. UVC and shortwave UVB wavelengths below 290 nanometers do not penetrate the earth's atmosphere and are harmful to animals.

UVB, Vitamin D and Calcium

The process of vitamin D synthesis in the skin of animals upon exposure to UVB is fascinating. Cholesterols in the skin are converted to a molecule known as previtamin D3 when the skin is exposed to UVB radiation. Upon exposure to heat, previtamin D3 undergoes a change and is converted to vitamin D3, which transforms in the liver and kidneys to the active form of vitamin D3. There are other molecules involved, and the process is regulated so that excess UVB exposure will not lead to an overdose of vitamin D, which is

fat soluble and carries a risk of overdose, as do all fat-soluble vitamins.

In addition to being a major component of bones and eggshells, calcium is involved in countless biological processes at the cellular level, including cell communication, muscle contractions and other functions that are essential to life. Vitamin D3 is responsible for calcium metabolism, and if there is not enough circulating vitamin D3 in the blood, animals are not able to use the calcium in their gut that they get from their food. Dietary calcium would then pass through the gut unused, and animals would be forced to take it from their bones, ultimately leading to a form of metabolic bone disease known as nutritional secondary hyperparathyroidism.

Animals can get vitamin D from two different sources: UVB-induced synthesis in the skin, or by ingesting vitamin D in the food that they eat. The livers of vertebrate prey, for instance, such as mice, rats and cod, provide a rich source of vitamin D3. Researchers have found, however, that not all reptiles and amphibians are able to adequately use dietary vitamin D3, and they depend on UVB-induced synthesis of vitamin D in the skin. Some of the reptiles for which this has been shown to be the case include

Fluorescent lamps that provide UVB, UVA and human-visible light.

Courtesy Shane Bagnall

Seen here is a Gooch & Housego model OL-756 scanning double-grating monochromator spectroradiometer (left) alongside a Solartech model 6.2 UV-B Solarmeter digital ultraviolet radiometer (right). Both are used to measure light.

Courtesy John C. Dowdy

Self-ballasted mercury vapor lamps provide UVB, UVA, human-visible light and heat from one source.

Courtesy Shane Bagnall

strictly herbivorous species, along with some insectivorous and omnivorous species (and the list is growing).

While some reptile species, such as the bearded dragon, could likely not survive without UVB-induced synthesis of vitamin D, others seem to do fine with what they get from their diet. Snakes are commonly kept by breeders in utilitarian enclosures containing a water dish, bedding, a hidebox and subterranean heat to provide a thermal gradient. These enclosures are often less than 6 inches tall, and the snakes are not provided with any lighting except for the ambient room lighting that may pass through the walls of the enclosure. Does this mean that snakes don't benefit from UVB? While this type of enclosure may be similar to what the snakes experience in a burrow, eventually they have to come out, and when they do they are often exposed to some level of UVB.

A Natural History Approach to Reptile and Amphibian Lighting

Often, we base husbandry practices on common sense and what has proven to work in the past, and many keepers provide specialized lighting only for species that need it to survive. Success in keeping reptiles and amphibians is often defined as being able to raise animals in captivity that appear healthy, and that hopefully breed and produce healthy offspring. Based on this success, the conclusion is drawn that if they can grow and reproduce without access to UVB,

Without UVB, this bearded dragon would be at risk of developing metabolic bone disease.

Courtesy Kirby Spencer / Zoo Med Laboratories

they must not need it. But this logic completely ignores the fact that many of these reptiles are exposed to UVB in their natural habitat, and new research shows that they do indeed benefit from UVB exposure.

Some species have been kept with apparent success without access to UVB, including nocturnal lizards; reptiles, such as snakes and varanids, that eat whole vertebrate prey; and amphibians. If we were to take a different approach and choose their lighting based on their interaction with light in nature, however, we would provide most of these species with UVB. Many of the species that are classified as "nocturnal" are also crepuscular (active at dawn and/or dusk), and crepuscular behavior patterns often result in exposure to low levels of sunlight and UVB.

These juvenile curly tailed lizards were bred at Zoo Med and are housed in a terrarium with a mercury vapor UVB lamp, which provides heat, light, UVA and UVB from one source.

Courtesy Kirby Spencer /Zoo Med Laboratories

UVB for Nocturnal Species

Herpetologists have often come across nocturnal species at dusk when low levels of UVB are present. In "Diurnal Activities of a Nocturnal Animal," a 1952 article published in the journal Herpetologica, noted herpetologist Bayard Brattstrom makes the following remarkable statement:

"The increasing mass of evidence regarding the function of the pituitary gland of animals in relation to solar radiation and sexual and other associated cycles, and the known importance of vitamin D and other physiological factors associated with absorption of solar radiation, would seem to make desirable the report of instances of diurnal activity observed in supposedly nocturnal animals. This is especially true for the species of terrestrial animals that habitually live underground during daylight hours, and which by means of protrusion of the head alone could presumably receive

adequate dosages of light sufficient to induce such responses as reported for birds and mammals."

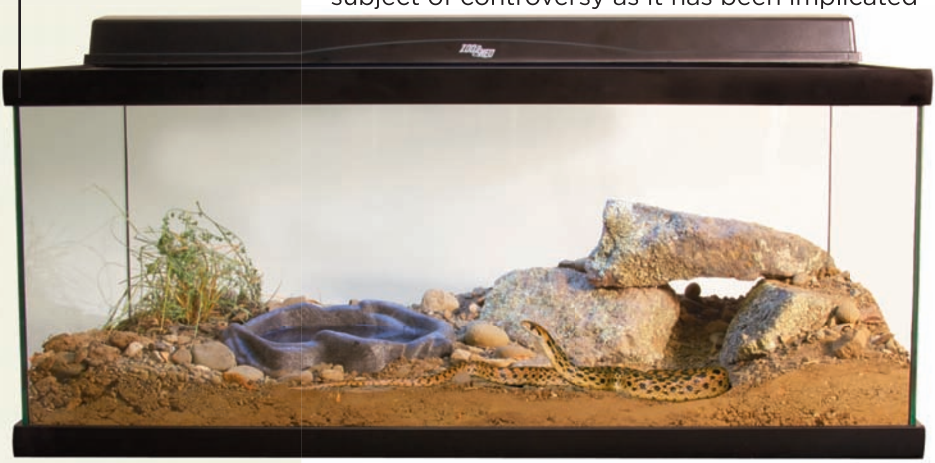
In this article, Brattstrom describes the observation of a desert banded gecko (Coleonyx variegatus variegatus) during the late afternoon when the sun was still above the horizon. I, too, have observed this species active during the late afternoon in Phoenix.

The important message is that nocturnal species occasionally expose themselves to UVB on purpose, and that this limited exposure to UVB may be enough to support a healthy vitamin D condition. Nearly 50 years after Brattstrom's observation, a study on house geckos revealed that this nocturnal/crepuscular species is extremely effective at synthesizing vitamin D with very little UVB exposure (Carman et al., 2000).

Based on these findings, it seems that for nocturnal and crepuscular species of reptiles, it is logical to recommend the use of lamps that provide low levels of UVB comparable to the levels found at dusk. In addition to providing a proper photoperiod, the lamps can also provide necessary UVB for vitamin D synthesis. Even if they only expose themselves to the light for short periods of time, that doesn't mean that animals don't benefit from the light. We use a toothbrush for only a few minutes each day, but imagine living without one!

What About Snakes and Amphibians?

With amphibians, UVB has often been the subject of controversy as it has been implicated



The author's gopher snake habitat contains UVB lighting, an undertank heater and a shelter to allow for photoregulation. This snake moves throughout the entire habitat and often exposes himself to UVB.

Courtesy Shane Bagnall

as a potential cause of amphibian decline. Indeed, too much UVB is harmful to any animal, and different species have differing tolerances for safe UVB exposure. As amphibians have become the focus of intensive captive-breeding projects, many zoos and breeders have found that low levels of UVB are necessary in order to maintain and breed various species. Breeders of dart frogs regularly use UVB lamps, and breeding projects involving the endangered Panamanian golden frog (Atelopus zeteki) also employ the use of UVB lamps with great success.

Even though many snakes can be raised and bred in captivity without the aid of UVB, the fact remains that most snakes receive UVB exposure in nature. There are many reports of snake activity when the sun is still out for species that are considered nocturnal. Some snakes, including rattlesnakes, racers, gopher and bull snakes, and garter snakes, are strongly diurnal and expose themselves to strong levels of UVB. Previously, the majority of the UVB studies on reptiles dealt mainly with lizards, but a recent study on corn snakes (Elaphe guttata) revealed that they, too, appear to have the ability to synthesize vitamin D upon exposure to UVB (Acierno et al., 2008).

As discussed earlier, UVA and UVB are also important in vision, behavior, reproduction and immune response. Due to the abundance of snakes bred in captivity, and their popularity as pets, they would seem to be an important group for future studies involving UVB and UVA radiation in the field of photoherpetology.

Aquatic turtles should be provided with UVB and a heat source to promote vitamin D3 synthesis and calcium metabolism.

Courtesy Kirby Spencer / Zoo Med Laboratories

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In Closing

As our knowledge of the UVB and lighting requirements of reptiles and amphibians grows, so will our ability to provide for their needs in captivity. When positioning UVB lamps over terrariums, be sure to follow manufacturer recommendations for appropriate lamp distances, and observe the behavior patterns of your reptile or amphibian. Take notice of unusual behaviors that may indicate that the lamp is too close or too far. Continual avoidance of the light for species that commonly bask is a good indication that the lamp is too close or too strong for that particular application. On the other hand, if an animal continually basks and exposes itself to UVB, without occasionally retreating to perform other natural behaviors, this may be an indication that the lamp is too far or that a stronger UVB lamp may be desirable. Care should be taken to ensure that a UVB gradient is provided and that the reptile or amphibian can retreat to a shelter where no UVB is present. This will allow them to photoregulate and adjust their exposure to UVB, just as they do with heat through thermoregulation.

The next time you set up a new habitat for a reptile or amphibian, take some time to research the natural history and behavior patterns of that species. Not only will this information prove to be interesting, it will also aid in helping you make an educated choice on the proper lighting requirements from a natural history perspective.

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Shane Bagnall studied herpetology at San Diego State University, where he received his degree in biology with an emphasis in zoology. Following his time at SDSU, he studied machining and manufacturing, which led him to the prestigious Salk Institute, where he designed and built custom scientific instruments. Shane is now a member of Zoo Med's research and development team, and he spends much of his free time studying the local herpetofauna of California's central coast. Visit Zoo Med at zoomed.com.