AN ULTRAVIOLET LIGHT SURVEY OF THREE SPECIES OF SEMI-AQUATIC SNAKES AT THE OLD SABINE BOTTOM WILDLIFE MANAGEMENT AREA, WITH INTRAORDER COMPARISONS AND MICROHABITAT DESCRIPTIONS

by

ANDREW MICHAEL BRINKER

Bachelor of Science, 1997
Michigan State University
East Lansing, Michigan

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INTRODUCTION

Basking behavior in reptiles has long been associated with thermoregulation (Cowles and Bogert, 1944; Huey and Slatkin, 1976; Huey and Webster, 1976; Sievert and Hutchison, 1988). Thermoregulation is not the only advantage behind reptilian basking. Snakes have been observed basking in winter and basking longer than necessary to attain preferred body temp (Hailey and Davies, 1987; Diener, 1957), behaviors that are not related to thermoregulation. UVB from sunlight is important in the cutaneous production of vitamin D in lizards (Jones et al., 1996; Carman et al., 2000; Ferguson et al., 2003, 2005). Laboratory experiments manipulating the dietary vitamin D of the panther chameleon *Furcifer pardalis* have shown that lizards in a low dietary vitamin D treatment spent significantly more time exposed to UVB than the treatment that received higher dietary vitamin D (Jones et al., 1996; Ferguson et al., 2003).

Exposure to ultraviolet light has historically been viewed for negative effects such as carcinogenesis, immunosupression, the global amphibian decline, DNA damage, etc. However, exposure to ultraviolet-B light radiation between the wavelengths 290-320nm has been shown to stimulate the cutaneous photobiosynthesis of previtamin D_3 from provitamin D_3 in several vertebrates (Webb and Holick, 1988; Webb et al., 1989; Allen et al., 1994). After the production of previtamin D_3 through cutaneous exposure to UVB, previtamin D_3 is thermally isomerized to vitamin D_3. Vitamin D_3 produced in the skin binds to the vitamin D-binding protein, enters the blood stream, and is carried to the liver, then the kidney, where it is converted into the biologically active form, 1,25-dihydroxyvitamin D_3 (Tian et al., 1994).

Vitamin D_3 is important in maintaining blood calcium levels (Webb and Holick, 1988), calcium metabolism (How et al., 1994), and maintenance of healthy bones (Lu et al., 1992). It causes absorption of calcium from the gut. It also interacts synergistically with parathyroid hormone, inhibiting its production and bone-resorbing effect. Vitamin D_3 can either be ingested or produced photobiosynthetically (Tian et al., 1994; Holick et al., 1995; Carman et al., 2000). Vitamin D3 content of many prey items is thought to be low (How et al., 1994), therefore photobiosynthesis may be an important source of vitamin D_3 in vertebrates.

Several lizard species have the ability to see ultraviolet light (Alberts, 1989; Fleishman et al., 1993, 1997; Ellingson et al., 1995; Loew, 1994; Shoji and Shozo, 1998; Sillman et al., 1997; Stoehr and McGraw, 2001), as do snake species (Sillman et al., 1999, 2001). This adaptation may play an important role in regulating exposure to ultraviolet light and maintaining proper vitamin D levels. Other potential uses for ultraviolet light vision could include finding prey, predators, mates, conspecific competitors, etc. In addition to ultraviolet light vision, both snake skin and sloughs allow the passage of UVB in the few species studied (Nietzke, 1990; Porter, 1967), with diurnal snakes allowing less UV to penetrate (more protection) than nocturnal (Porter, 1967). Snakes administered vitamin D_3 through intraperitoneal injections showed elevated serum calcium and phosphate levels (Srivastav and Rani, 1992; Kagwade and Pangaonkar, 1995; Srivastav et al., 1995). The afore mentioned research combined with the close phylogenetic relationship between lizards and snakes (Order Squamata) suggest that snakes may also have the ability to produce vitamin D through cutaneous exposure to UVB and possibly photoregulate their vitamin D-condition through basking.

The present study determined the in-situ UVB exposure of snakes at the Old Sabine Bottom Wildlife Management Area in East Texas. During the daylight hours the UVB environment of three species of semi-aquatic snakes with different ecologies were surveyed: the crepuscular/nocturnally active cottonmouth (*Agkistrodon piscivorus*), the diurnally active yellow-bellied water snake (*Nerodia erythrogaster*), and the diurnally active ribbon snake *(Thamnophis proximus*). The activity period of all three snakes may be diurnal in cooler months and nocturnal in the warmest months.

The western cottonmouth in East Texas is a heavy-bodied snake between 61 and 91.4 cm in length (Werler and Dixon, 2000). Cottonmouths can be found in a variety of habitats, including brackish coastal marshes, cypress and palmetto swamps, ponds, and clear upland streams (Werler and Dixon, 2000). Diet includes reptiles, fish, amphibians, birds, mammals, and invertebrates (Werler and Dixon, 2000).

The yellow-bellied water snake is typically between 61 and 91.4 cm in length (Werler and Dixon, 2000). Yellow-bellied water snakes are found near slow moving or still water, including ponds, lakes, swamps, bayous, and bottomland forest (Werler and Dixon, 2000). Diet includes mostly anurans, followed by fish and then salamanders (Werler and Dixon, 2000).

The western ribbon snake is a very slender snake, most often between 50.8 and 76.3 cm in length (Werler and Dixon, 2000). The western ribbon snake inhabits grassy or brushy margins along both still and moving bodies of water, including marshes, damp meadows, swamps, sloughs, ponds, lakes, springs, streams, and rivers (Werler and Dixon, 2000). Frogs, toads and their larvae are the primary food item, followed by fish and salamanders (Werler and Dixon, 2000).

The daytime exposure to UVB of all three species was assessed in-situ using a digital UVB meter. The survey of UVB exposure allowed a comparison between these three species of snakes and several species of lizards previously studied. Field observations were used to determine preferred habitat preference of cottonmouths, ribbon snakes, and banded water snakes at the Old Sabine Bottom Wildlife Management Area.

METHODS

The survey of UVB exposure in snakes was conducted at Old Sabine Bottom Wildlife Management Area (OSBWMA) in Smith County, Texas. The OSBWMA is a 2,087-ha bottomland hardwood forest in North East Texas, managed for hunting by Texas Parks and Wildlife. Twenty-two trips from March 2005 through April 2006 were conducted, including over 500 man-hours spent in the field. Twenty of these trips were taken between March and June with 118 man hours spent in March, 128 man-hours spent in April, 130 man hours spent in May, 120 man-hours spent in June. July and August were not sampled do to the extreme heat and reduced diurnal activity of snakes. From September through November only two trips were taken, one each in September and October. Sampling during the fall was difficult due to hunting restrictions that didn't allow us on the property. Field assistants were only absent on three of the twenty-two trips.

The OSBWMA was divided into three approximately equal sections: 1. East 2. Center 3. West. To equally sample the study site the field time was divided into three-day periods in which each site would be sampled for an entire day. Sampling methods consisted of visually searching for exposed snakes, while walking trails through the study site and investigating likely refugia (ponds, ephemeral pools, patches of sunlight, tree falls, etc). All sampling began at approximately 0900 and continued through 1900 (10 hours sampling), unless returning to Fort Worth, TX in the evening, in which case sampling ended at 1700 (8 hours sampling).

When an exposed snake was encountered, the snake was either moving or stationary. If the snake was moving a UVB reading was taken with a Solartech 6.2 UVB meter (Solartech Inc., Harrison Township, MI) at the initial observation site. Two readings were taken, one with the sensor surface parallel to the ground and one with the sensor surface perpendicular to the ground. All reported readings were from the perpendicular reading, which is a more accurate estimate of exposure and the reading used in previous UVB surveys. The Solartech meter tends to overestimate the levels of UVB when used in natural sunlight by a predictable amount. In order to compare my readings with those measured on lizards by Gary Ferguson (unpublished data) who used the more accurate Gigahertz-Optik broadband light meter, a conversion formula was applied (Fig. 1). All UVB data were multiplied by 0.451 before performing statistics.

If the snake was stationary, a UVB reading was recorded in a similar light environment (i.e. shade, full sun, filtered sun) every five minutes for up to a half hour. The light environment was also scored between 1 and 5, with 1 being full sun and 5 being full shade. In both scenarios the GPS location was recorded with a Garmin E-Trex Legend (Garmin Int. Inc., Olathe, KS), along with notes on the habitat. Snakes were captured by hand if possible (excluding *A. piscivorus*), and body surface temperature

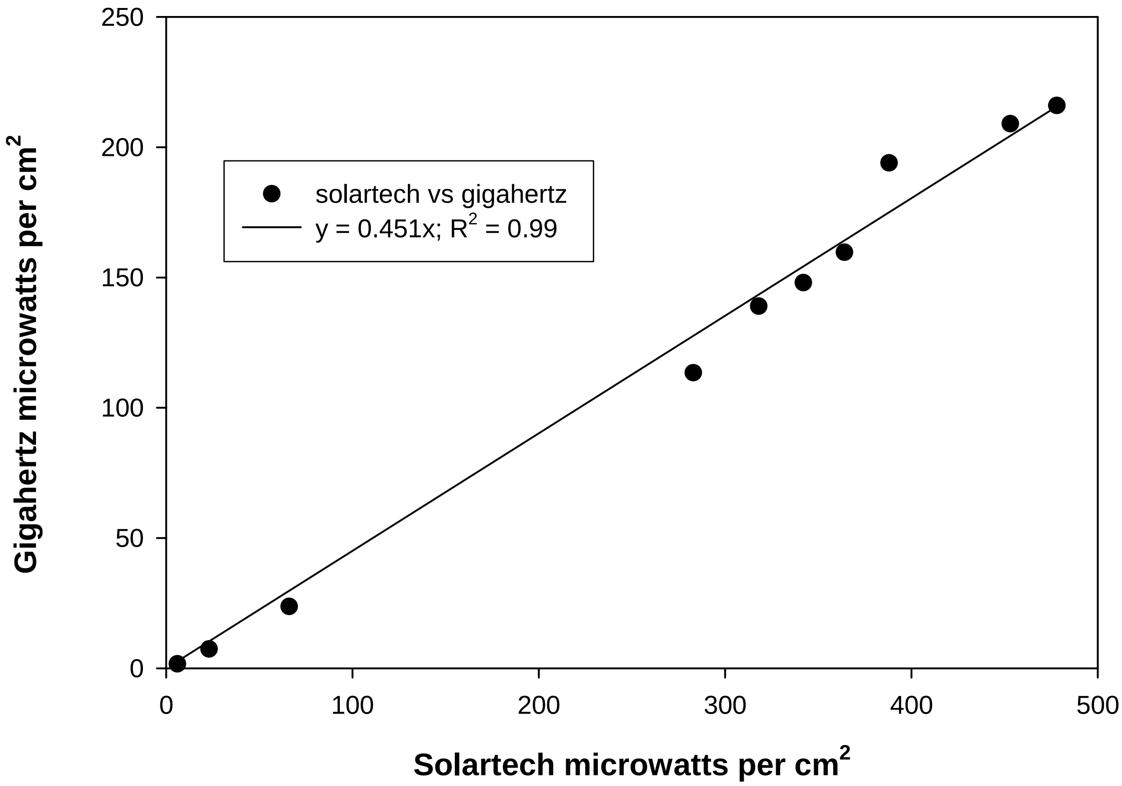

Figure 1. UVB readings on a Gigahertz broad band light meter as a function of readings from a Solartech 6.2 UVB meter, both simultaneously exposed to the sun.

was immediately taken using a non-contact thermometer, Raytek MiniTemp (Raytek corp., Santa Cruz, CA) while holding the snake in hand and lining the laser guide on the dorsal surface of the posterior end of the snake, which was not in contact with the capture hand. Body surface temperatures for *A. piscivorus* were taken by lining the laser guide on the dorsal surface of the snake within 60cm. As the Raytek non-contact thermometer moves away from the object being tested the diameter of the sensor field increases (approximately 8cm at 60cm), giving a less accurate reading due to background interference. Other data recorded included snout-vent length, tail length and body weight.

RESULTS

A total of 512 man-hours of observation were spent during 6 months. March, April, May and June were sampled similarly with the range being 118 man-hours in March to 130 man-hours in May (Table 1.). September and October were both sampled for only a single day (Table 1.). The total man hours for each month were divided by the number of UVB readings taken in that month providing - Average Search Hours Per Reading (Table 1.)

Month	hrs	# of readings	hrs/reading
March	118	1	118.00
April	128	19	6.74
May	130	21	6.19
June	120	12	10.00
September	8	1	8.00
October	8	0	-
Total	512	54	-

Table 1. Temporal analysis of search effort and efficiency of UVB survey of semi-aquatic snakes at the Old Sabine Bottom Wildlife Management Area of northeastern Texas.

The GPS location for all encounters with *A. piscivorus* [N=11], *N. erythrogaster* [N=10], and *T. proximus* [N=19] exposed to UVB were mapped in Figure 2. *Agkistrodon piscivorus* were found three times sitting on the banks of ponds, twice on roads, five times in shallow ephemeral pools, and one time in a dried depression, away from water (approximately 30m from standing water). *Nerodia erythrogaster* was found four times basking within 0.5 meters of water; the remaining six times the *N. erythrogaster* were encountered away from water (between 10 and 50 meters from standing water). Of the six times found away from water three were on the move while three were stationary basking. *Thamnophis proximus* were encountered 10 times within 1 meter of water. Of these 10 encounters, 8 were near ephemeral pools of water and two were around permanent pools of water. The remaining nine times were more than 3 meters from water. Of these nine times, 6 were in wooded areas and three in grassy areas.

Resting *A. piscivorus* were found in coiled resting positions in the shade. These locations were within a few meters of large ephemeral pools or permanent water sources (Figure 2). Active snakes were encountered in filtered sunlight on the road or while foraging in shallow ephemeral pools away from large ephemeral pools or permanent water sources (Figure 2). These findings agree with Werler and Dixon (2000), who report *A. piscivorus* in East Texas confined to large and small ponds in swamps and river bottoms. The resting *A. piscivorus* were likely in ambush postures awaiting the small mammals, reptiles or birds while the active snakes were likely foraging for fish and anurans.

Thamnophis proximus also exhibited two preferred habitats both in filtered sunlight, one while resting and the other while active. When resting, *T. proximus* were usually encountered on sparsely vegetated open areas away from large ephemeral pools or permanent water sources (Figure 2). Active snakes were encountered near small ephemeral pools in the forest (Figure 2). The preferred habitat described here is consistent with Werler and Dixon's (2000) habitat description, although Werler and Dixon (2000) state that this species is not considered a forest dweller and make no mention of bottomland forest. Resting snakes appeared to be asleep, remaining motionless even when I was within a meter of the snake. Active snakes were likely foraging for anurans and their larvae.

Nerodia erythrogaster again showed a preference for two habitats, although these habitats were different in sun exposure but not in activity of the snake. *Nerodia erythrogaster* that were found near large ephemeral pools or permanent water were either basking or foraging, both in full sunlight (Figure 2). Snakes encountered away from water were either resting or foraging in filtered sunlight (Figure 2). These findings agree with Werler and Dixon (2000) who describe a variety of habitats, all having slow moving or stagnant waters, including bottomland forest. Snakes close to permanent water were likely foraging on both anurans and fish, while those away from water were likely foraging for anurans and salamanders. *N. erythrogaster* was the most terrestrial of the *Nerodia* species seen, which was also reported by Mushinsky et al., 1980.

The mean surface body temperature was highest in *T. proximus* at 28.9C [N= 8]. *Agkistrodon piscivorus* had an intermediate mean surface body temperature at 26.4C [N= 4]. *Nerodia erythrogaster* had the lowest mean surface body temperature at 25.9C [N= 4] (Fig.3).

The mean UVB exposure ($\pm$ S.E.) was highest in *N. erythrogaster* at 36.6 $\pm$ 8.2 $\mu W/cm^{-2}$ [N= 18]. *Thamnophis proximus* had an intermediate UVB exposure at 28.8 $\pm$ 6.5 $\mu W/cm^{-2}$ [N= 19]. *Agkistrodon piscivorus* had the lowest mean UVB exposure at 10.3 $\pm$ 1.9 $\mu W/cm^{-2}$ [N= 17] (Fig.3).

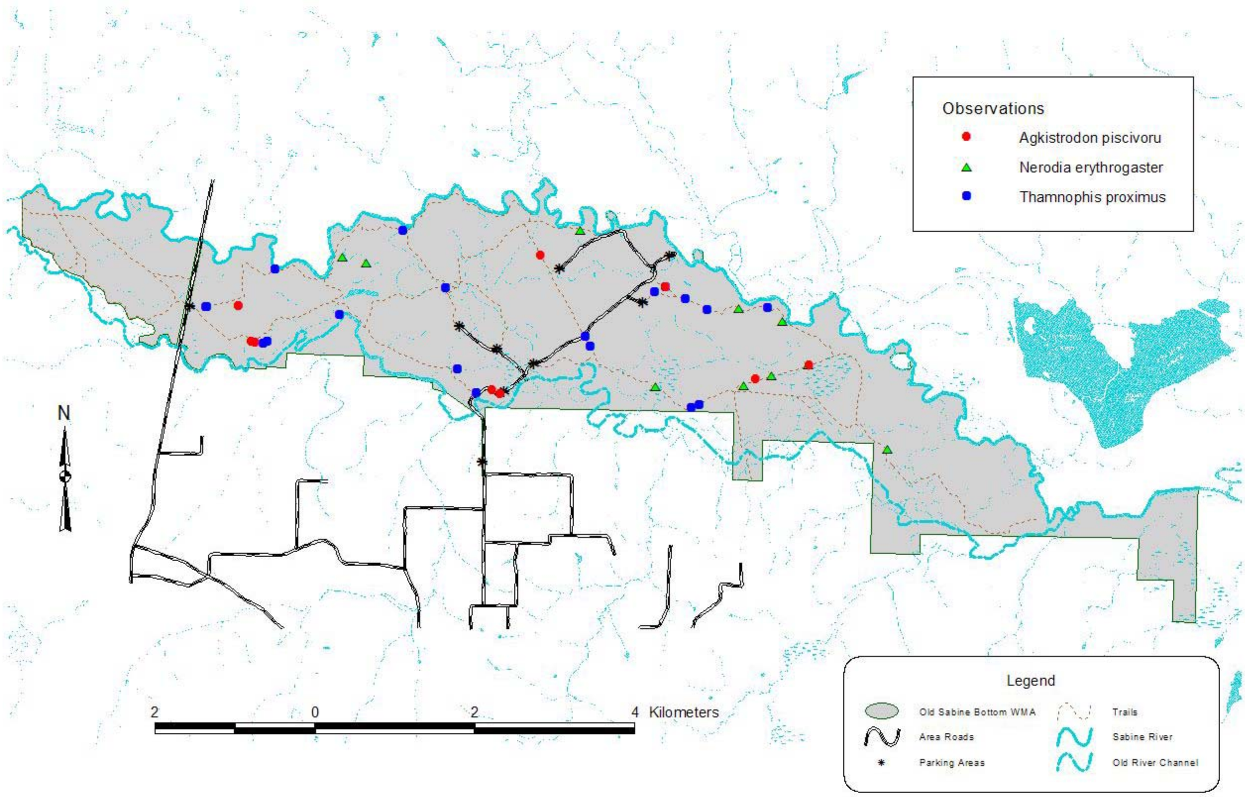

Figure 2. GPS locations for all encounters with exposed *Agkistrodon piscivorus*, *Thamnophis proximus*, and *Nerodia erythrogaster*.

There was an overall difference among taxa in UVB exposure (ANOVA; $p<0.002$). The pairwise comparisons showed that *A. piscivorus* had a significantly different mean exposure than either *T. proximus* ($p=0.001$) or *N. erythrogaster* ($p<0.001$). *Thamnophis proximus* was not significantly different than *N. erythrogaster* ($p=0.674$).

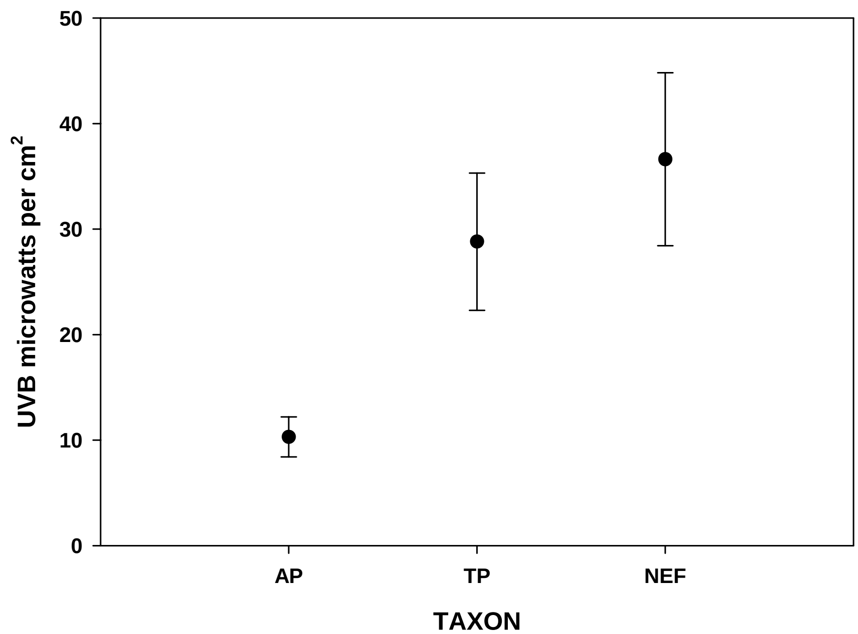

Figure 3. The mean UVB exposure of *Agkistrodon piscivorus* (AP), *Thamnophis proximus* (TP), and *Nerodia erythrogaster* (NEF). Vertical capped lines are one standard error.

DISCUSSION

Interspecific differences

The results showed a significant difference in mean UVB exposure between *A. piscivorus* and both *N. erythrogaster* and *T. proximus*, but not between *N. erythrogaster* and *T. proximus*. There are three possible interpretations of these data; the first two assume snakes have the ability to cutaneously produce vitamin D: 1. A difference in skin sensitivity between *A. piscivorus* and both *N. erythrogaster* and *T. proximus*, but no difference in skin sensitivity between *N. erythrogaster* and *T. proximus*. 2. A difference in dietary vitamin D between *A. piscivorus* and both *N. erythrogaster* and *T. proximus*, but no difference in dietary vitamin D between *N. erythrogaster* and *T. proximus*. 3. *A.*

piscivorus has a different preferred body temperature than both *N. erythrogaster* and *T. proximus*, but there is no difference in preferred body temperature between *N. erythrogaster* and *T. proximus*.

Skin Sensitivity. Lizard species occupying different ecological niches have been shown to have different skin sensitivity to UVB (Carman et al., 2000; Ferguson et al., 2005). Generally those species that are usually exposed to high amounts of UVB irradiation in nature are not as efficient at the cutaneous production of vitamin D as those species that are exposed to lower quantities of UVB irradiation. This can also be interpreted as protection from UVB, with lizard species that experience higher UVB having better protection from damage through thicker scales (e.g., *Sceloporus olivaceus*), while those species that experience low exposure to UVB have less protection (e.g.. *Hemidactylus turcicus*). *Agkistrodon piscivorus* may therefore have a lower mean UVB exposure than both *N. erythrogaster* and *T. proximus* because of a difference in microhabitat (less UVB), resulting in the evolution of a more sensitive skin than both *N. erythrogaster* and *T. proximus*, which require more protection in their higher UVB microhabitat. *Agkistrodon piscivorus* is also more nocturnally active than either *N. erythrogaster* or *T. proximus*, making it potentially advantageous to have a more sensitive skin due to less UVB exposure opportunities.

Dietary vitamin D. The dietary studies on *Furcifer pardalis* by Jones et al., 1996 and Ferguson et al., (2003) have demonstrated the ability to regulate its vitamin D through exposure to UVB depending on its dietary intake of vitamin D. Anurans make up the majority of the diet of *N. erythrogaster*, although fish are also an important component (Werler and Dixon, 2000). *T. proximus* feeds almost exclusively on anurans and their larvae (Werler and Dixon, 2000) *A. piscivorus* is more of a generalist and feeds on fish, reptiles, amphibians, small mammals, birds, and invertebrates (Werler and Dixon, 2000). Unfortunately, no food samples were analyzed during this research, although a difference in dietary vitamin D is possible due to the known difference in diets. If dietary vitamin D is higher for *A. piscivorus*, then the data could be explained by *A. piscivorus* choosing a lower UVB environment than both *N. erythrogaster* and *T. proximus* due to lower vitamin D needs resulting from higher ingested vitamin D.

Preferred body temperature. The data obtained may be a result of lower preferred body temperature of *A. piscivorus* than both *N. erythrogaster* and *T. proximus*. *Nerodia erythrogaster* had the lowest mean surface temperature, which was lower than the mean internal body temperature reported in a field study by Brattstrom (1965) of 29.0C [N=4]. Mushinsky et al. (1980) took internal body temperatures of 174 *N. erythrogaster* in the field over three years: 1976 – 25.8C, 1977 – 25.7C, 1978 – 28.0C. The internal body temperature reported in 1976 and 1977 correlated closely with our mean surface body temperature. Gehrmann (1971) conducted experiments comparing *N. erythrogaster* preferred body temperatures in the lab. There were two treatments of snakes, those exposed to 24 hours of light and those exposed to 12 hours of light and 12 hours of darkness, the latter group showing a preferred body temperature of approximately 27.6C. My reported mean surface body temperature of 25.9C is within the range of preferred internal body temperatures reported in the literature, and a likely estimate of preferred body temperature.

Brattstrom (1965) reported a mean internal body temperature of 26.2 [N=11] for *A. piscivorus* in the field. My reported mean surface body temperature of 26.4C is nearly identical with the internal body temperature reported by Brattstrom (1965), suggesting an accurate estimate of preferred body temperature. The data in this study therefore suggests a higher preferred body temperature for *A. piscivorus* than *N. erythrogaster*.

The preferred surface body temperatures reported in this study correlate with those in the literature suggesting that the significantly higher mean UVB exposure in *N. erythrogaster* as compared to *A. piscivorus* is not due to a difference in preferred body temperature. The significant difference in mean UVB exposure between *T. proximus* and *A. piscivorus* may be due to the higher preferred body temperature of *T. proximus*. Due to the small sample size, the above conclusions should be taken cautiously.

Intraspecific differences

The difference in mean UVB exposure between these three species was the focus of this research, although future research should examine the intraspecific variation in mean UVB exposure. Research has shown that gravid female *Thamnophis* maintain higher body temperatures than nongravid females (Charland, 1995), and that gravid female *Liasis* bask more than males or nongravid females (Shine and Madsen, 1996). Presumably this is to maintain higher temperatures for the developing embryos. However, during this time there is a high calcium demand on the female as she provides calcium for the developing embryo. In order to increase or maintain the levels of serum calcium circulating in the blood, vitamin D is crucial, and gravid females basking in sunlight may not only be thermoregulating but also increasing serum calcium levels through the cutaneous production of vitamin D, as shown by Jones et al. (1996) for gravid female panther chameleons. Gravid panther chameleons voluntarily exposed themselves to significantly more UVB than non-gravid females. In their experiment, the UVB source did not provide heat and thermoregulation was not involved. Juvenile snakes also have a high calcium demand as they are growing, and one would expect a juvenile that is constantly basking to accelerate digestion, may also be basking to increase serum calcium levels through the cutaneous production of vitamin D levels.

Comparisons between squamates and habitat correlations

The mean UVB exposure of *A. piscivorus* is the lowest of all the diurnal/crepuscular squamates so far studied (Fig. 4, Table 2). *T. proximus* is intermediate, with three species of lizards and three species of snakes showing a lower mean UVB exposure, and one species of snake and 5 species of lizards having a higher mean UVB exposure (Fig. 4, Table 2). Exposure of *N. erythrogaster* is slightly higher than that of *T. proximus* and otherwise includes the same number of species below and above as *T. proximus* (one additional snake species with a lower mean UVB exposure, and no snake species with a higher mean UVB exposure) (Fig. 4, Table 2). The five squamates with the highest mean UVB exposures were all lizards. *Sceloporus undulatus garmani* had the highest mean UVB exposure at 118.7 ± 34.8 $\mu W/cm^{-2}$ [N=3] although the sample size was very small. *Holbrookia maculata* had the second highest mean UVB exposure at 108.6 ± 7.8 $\mu W/cm^{-2}$ [N=25].

The three lizards that had lower mean UVB exposures than both *N. erythrogaster* and *T. proximus* included: *Anolis lineotopus* 16.7 ± 3.5 $\mu W/cm^{-2}$ [N=17], *A. grahami* 24.7 ± 3.7 $\mu W/cm^{-2}$ [N=12], and *A. carolinensis* 26.8 ± 6.2 $\mu W/cm^{-2}$ [N=19]. Tropical reptiles may not have the same thermoregulatory demands due to ambient temperatures closer to preferred body temperatures (Shine and Madsen, 1996). The low mean UVB exposures of the two tropical lizards *A. lineotopus* and *A. grahami* might be attributed to more sensitive skins due to the reduced need for thermoregulation.

Uta stansburiana had a mean UVB exposure that was 6.6 μW/cm^{-2} higher than *N. erythrogaster*. This is a small difference for species inhabiting such different habitats; *Uta stansburiana* inhabits temperate deserts, whereas *N. erythrogaster* inhabits forests close to water. *Sceloporus undulatus hyacinthinus* has a mean UVB exposure that is 25.3

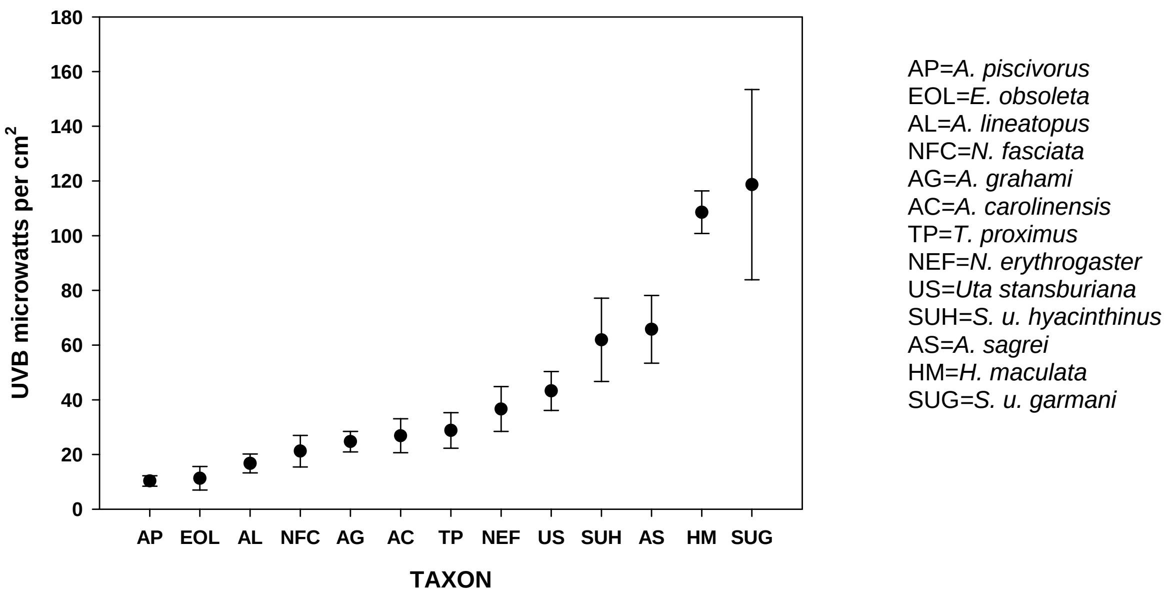

Figure 4. The mean UVB exposure of 5 species of snakes and 8 species of lizards that show daytime exposure to light. *Agkistrodon piscivorus* has the lowest mean UVB exposure, while both *Thamnophis proximus* and *Nerodia erythrogaster* are intermediate. There are three *Anolis* species that are between *A. piscivorus* and *T. proximus*. Vertical capped lines are one standard error.

μW/cm^{-2} higher than *N. erythrogaster,* even though it inhabits a similar habitat to *N. erythrogaster* (temperate forests). The relationships between these lizards and snakes may involve preferred body temperatures, dietary vitamin D, skin sensitivity, or some combination of the above. Studies controlling for these factors may allow future investigators to tease out the UVB correlations between different squamates.

Species	Suborder	Habitat	UVB microwatts cm^{-2} (mean ± S.E. [N])
Agkistrodon piscivorus	Snake	Temperate forest semi-aquatic	10.3 ± 1.9 [17]
Elaphe obsoleta	Snake	Temperate forest arboreal	11.3 ± 4.3 [7]
Anolis lineotopus	Lizard	Tropical forest terrestrial shade	16.7 ± 3.5 [17]
Nerodia fasciata	Snake	Temperate forest semi-aquatic	21.2 ± 5.8 [6]
Anolis grahami	Lizard	Tropical forest arboreal	24.7 ± 3.7 [12]
Anolis carolinensis	Lizard	Temperate forest arboreal	26.8 ± 6.2 [19]
Thamnophis proximus	Snake	Temperate forest semi-aquatic	28.8 ± 6.5 [19]
Nerodia erythrogaster	Snake	Temperate forest semi-aquatic	36.6 ± 8.2 [18]
Uta stansburiana	Lizard	Temperate desert terrestrial	43.2 ± 7.1 [13]
Sceloporus undulatus hyacinthinus	Lizard	Temperate forest arboreal	61.9 ± 15.2 [18]
Anolis sagrei	Lizard	Tropical terrestrial	65.7 ± 12.4 [13]
Holbrookia maculata	Lizard	Temperate grassland	108.6 ± 7.8 [25]
Sceloporus undulatus garmani	Lizard	Temperate grassland	118.7 ± 34.8 [3]

Table 2. The mean UVB exposure and habitat of 5 species of snakes and 8 species of lizards that show daytime exposure to sunlight.

Future studies

In order to ascertain whether snakes have the ability to generate vitamin D through exposure to UVB, the analysis of photoproduction of vitamin D is currently underway for *N. erythrogaster* following the same methods as Jones et al. (1996), Carman et al. (2000), and Ferguson et al. (2003, 2005). Other studies are needed to identify the importance of UVB to these semi-aquatic snakes. One such study could manipulate the amount of dietary vitamin D. The hypothesis being that the snakes receiving low dietary vitamin D would voluntarily expose themselves to a higher dosage of UVB, given a UVB gradient.

Ferguson et al. (2005) have recently demonstrated that female panther chameleons (*Furcifer pardalis*) that are exposed to UVB lay eggs containing more vitamin D than females that were not exposed to UVB. Gravid female *N. erythrogaster*, *T. proximus*, or *A. piscivorus* could be exposed to different amounts of UVB using the results of this study as the medium exposure group and the neonates analyzed for vitamin D content to see if neonatal vitamin D condition is affected.

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VITA

Andrew Michael Brinker was born March 8, 1979, in Saginaw, Michigan. He is the son of Henry Brinker and Linda Brinker. A 1997 graduate of Huron High School, Ann Arbor, Michigan, he received a Bachelor of Science degree with a major in Zoology from Michigan State University, East Lansing, in 2001.

Upon graduating from Michigan State University in 2001, he joined the Fort Worth Zoological Association as a keeper in the herpetology department. While employed by the zoo, he enrolled in graduate study at Texas Christian University. He was awarded a teaching assistantship for 2004-05, and 2005-06 academic years.

He is currently a member of the Society for the Study of Amphibians and Reptiles, Herpetologist League, and American Society for Ichthyologists and Herpetologists.

ABSTRACT

AN ULTRAVIOLET LIGHT SURVEY OF THREE SPECIES OF SEMI-AQUATIC SNAKES AT THE OLD SABINE BOTTOM WILDLIFE MANAGEMENT AREA, WITH INTRAORDER COMPARISONS AND MICROHABITAT DESCRIPTIONS

By Andrew M. Brinker, M.S., 2006
Department of Biology
Texas Christian University

Thesis Advisor: Dr. Gary W. Ferguson, Professor of Biology

Ultraviolet light is typically associated with negative effects (e.g. cancer, sunburn etc.). However, recent studies have demonstrated the importance of ultraviolet light for calcium metabolism through production and regulation of vitamin D_3. The present study surveyed the UVB exposure of three species of snakes at the Old Sabine Bottom Wildlife Management Area, in East Texas. Exposure of 40 snakes encountered in the field during daylight hours was measured with a Solartech 6.2 UVB meter. *Agkistrodon piscivorus* had the lowest mean UVB exposure ($10.3 \pm 1.9\ \mu W\ cm^{-2}$), while *Nerodia erythrogaster* experienced the highest mean UVB exposure ($36.6 \pm 8.2\ \mu W\ cm^{-2}$). *Thamnophis proximus* showed an intermediate UVB exposure ($28.8 \pm 6.5\ \mu W\ cm^{-2}$). Possible reasons for the differences of mean UVB exposure are discussed. The mean UVB exposure of the three snake species was also compared with that of 8 species of lizards. Finally, the microhabitat was described for each species of snake.