PHOTO-KERATO-CONJUNCTIVITIS IN REPTILES

Frances M. Baines, MA Vet MB MRCVS[1]

[1]Greenfield, School Lane, Govilon, Abergavenny, Monmouthshire, NP7 9NT Wales, UK

INTRODUCTION

Photo-kerato-conjunctivitis (PKC) is rarely included in the differential diagnosis for the reptile patient with eye problems; nevertheless many cases have been seen worldwide over the last three years.[1,2] The first study of photo-kerato-conjunctivitis and photo-dermatitis in reptiles has only recently been published.[3] Apart from this, only a few broad descriptions of the symptoms of "over-exposure" of laboratory animals to ultraviolet (UV) light can be found in the literature. [4,5,6]

Between July 2006 and December 2009, the current author has collected reports of 65 incidents involving more than 175 reptiles apparently affected by PKC, of which 12 also suffered skin lesions consistent with UV radiation damage, and 20 died.
The details of each incident were collected by email or telephone exchanges with the owner or with the veterinarian examining the affected animals. Eleven of the lamps associated with specific incidents were submitted for analysis. New lamps of each specified brand and type were also obtained. The UV output of these lamps was measured using a spectrophotometer (Ocean Optics USB2000/ 2000+, Ocean Optics, Dunedin, FL34698, USA) and two broadband meters (Solarmeter 6.2 UVB and 6.5 UV Index meters, Solartech Inc., Harrison Township, MI 48045, USA)

47 incidents were associated with the introduction of just three specific brands of UV lamp into the vivarium. These were the ZooMed Reptisun 10.0 Compact Lamp (ZooMed Labs Inc, San Luis Obispo, CA93401, USA) and lamps from the R-Zilla Desert 50 and Tropical 25 Series (Central Garden & Pet, Franklin, WI 53132, USA). The remaining 18 incidents were associated with the use of five other brands. The data is summarized in Table 1.

Table 1. Lamps associated with photo-kerato-conjunctivitis in reptiles

Company and Brand Name	Lamp type	Number of incidents reported	Number of affected animals	Number of deaths	Period in which cases occurred
ZooMed Reptisun 10.0. (ZooMed Labs Inc, San Luis Obispo, CA93401, USA)	Compact fluorescent lamps	28	40	4	July 06 - July 09
R-Zilla Desert 50 Series. (Central Garden & Pet, Franklin, WI 53132, USA)	Linear fluorescent tubes and compact lamps	10	>57	6	July 07 - Sept 08
R-Zilla Tropical 25 Series. (Central Garden & Pet, Franklin, WI 53132, USA)	Linear fluorescent tubes and compact lamps	9	28	7	May 08 - Aug 09

Ferplast UV-B 10%. (Ferplast S.p.A., 36070 Castelgomberto, Vicenza, Italy)	Linear fluorescent tubes	1	7	2	Nov 07
ReptaPets Australia Sun Plus UV. (Weihai Gao Cheng Tech Pty Ltd., Ringwood, VIC 3134 Australia)	Linear fluorescent tubes	2	20	1	Dec 07 - Jun 08
ZooMed Reptisun 5.0. (ZooMed Labs Inc, San Luis Obispo, CA93401, USA)	Compact fluorescent lamps	2	10	0	Dec 06 - May 07
ExoTerra ReptiGlo 10.0. (Rolf C Hagen Corp, Mansfield, MA 02048, USA)	Linear fluorescent tubes and compact lamps	5	5	0	Nov 07 - Mar 08
ZooMed 100W Powersun. (ZooMed Labs Inc, San Luis Obispo, CA93401, USA)	Mercury vapour lamps	7	7	0	Jan 09 - Sept 09

CLINICAL PRESENTATION

Typically, the owners of affected reptiles noticed symptoms within 24 – 48 hours of the introduction of a new UV lamp. Initially, most reptiles developed blepharospasm in one or both eyes. Some avoided the light; many others refused to bask, feed or drink and appeared to be in pain, sitting motionless with their eyes closed.
More severely affected animals developed blepharitis and more rarely, lesions resembling burns around the eyes, with damage to the conjunctiva, exudate and scab formation.

These symptoms are highly suggestive of acute photo-kerato-conjunctivitis. Although no detailed studies appear to have been made on this condition in reptiles, studies in mammals show that exposure to excessive short-wavelength UV radiation results in rapid development of a superficial punctate keratitis, which in severe cases, is followed by total epithelial desquamation, inflammation, edema, and pain. In man, significant ocular pain develops between six and twelve hours after exposure.[7]

Twelve reptiles also developed skin lesions resembling burns over the head, the back or even the whole body. This appeared to have been the primary cause of death in three cases; in two others, secondary infection of the necrotic tissue was probably a major contributing factor. The other deaths, particularly in young hatchlings, may have occurred as a result of their blindness and subsequent inability to thermoregulate or take fluids, coupled with the stress associated with acute pain.

Mild cases in which blepharospasm (with or without blepharitis) was the main presenting symptom underwent a rapid, complete recovery within 24 – 72 hours of removing the lamp. Some owners switched off the new lamp almost at once, which led to a swift resolution of the problem. Others only identified the lamp as a possible cause

after prescribed eye ointments and/or shop-bought remedies had proven ineffective over many weeks. In two cases this rapid recovery occurred after five months and six months, respectively, of unsuccessful treatment whilst the reptiles were still being exposed to the light from the lamp.
This is a very similar rate of recovery to that seen in humans affected by photokeratitis. Corneal re-epithelialization in man occurs over a 36- to 72-hour period.[7]
In severe cases, however, general debilitation or more extensive damage to the eyes or skin delayed recovery for up to a week or more. Nevertheless, all surviving reptiles made a complete recovery once the lamp was removed, and none required further treatment for any other eye condition.
In five separate instances, the offending lamp was temporarily re-introduced and symptoms re-occurred before the lamp was removed again. However, no re-occurrence of symptoms was reported in any case where the UV lamp was changed to a different brand that has never been associated with PKC.

HISTOPATHOLOGY

Histology performed on samples from two dead reptiles (one snake and one lizard) supported the diagnosis of radiation damage that had been made based on the gross lesions[3]. Skin samples from both animals revealed severe epidermal basal cell degeneration and necrosis. Numerous shrunken keratinocytes undergoing apoptosis were identified within the basal and suprabasal cell layers. These cells, often called "sunburn cells", are characteristic of damaging exposure to ultraviolet light. A section through the eye of the snake showed complete destruction of the spectacle, severe corneal ulceration with kerato-conjunctivitis, neovascularisation, secondary bacterial infection, and anterior uveitis.

LAMP ANALYSIS

The effect of radiation upon the eyes and skin depends both upon the dose (its intensity and duration) and the wavelengths present in the lamp's spectrum. Wavelengths below 300nm have a far greater potential for damage to living cells than those above 300nm. For example, the human action spectra for photo-keratitis and photo-conjunctivitis[8] indicate that UV-B at 285nm is approximately 6 times more effective at producing threshold keratitis and 80 times more effective at producing threshold conjunctivitis than UV-B at 305nm.

Broadband meters were used to assess the intensity of the radiation from each lamp at the distances at which they had been placed above the affected reptiles.

The Solarmeter 6.2 UV-B meter gives a reading for total UV-B output in microwatts per square centimetre (µW/cm²). The total UV-B output from these lamps at the distances at which the reptiles were affected was found to be unremarkable. The great majority of reptiles appeared to have developed photokeratitis with total UV-B levels between 100 and 350 µW/cm². These are typical readings for natural early to mid-morning sunlight in subtropical regions, and yet reptiles basking in natural sunlight do not develop photo-kerato-conjunctivitis.
However, the Solarmeter 6.2 measures the output across the entire UV-B range of wavelengths; it cannot be used to identify lamps emitting particularly short-wavelength UV-B.

The Solarmeter 6.5 meter, designed to measure the UV Index (UVI), has a weighted response towards the more photo-reactive shorter wavelengths. At the distances at which the reptiles were affected, the readings from this meter from the lamps were a cause for concern. The majority of readings were above UVI 11.0; one lamp gave a reading of UVI 56.4. This is abnormal and potentially damaging irradiation. The highest voluntary exposure recorded for a heliothermic lizard in a recent field study was UVI 9.5.[9] Levels over 11.0 are defined as 'extreme' by the World Health Organization.

Spectral analysis of the lamps associated with cases of PKC confirmed that these specific brands were emitting a higher proportion of their total UV-B below 300nm than natural sunlight and other lamps that have never been associated with PKC.
Most of the fluorescent lamp samples were also producing significant radiation between 280nm and 290nm ("non-terrestrial UV-B"). Natural sunlight (except at very high altitudes) contains no UV with wavelengths shorter than 290nm, and only very small amounts of UV-B between 290 and 300nm.

In simple terms, these lamps did not appear to be supplying "too much UV", but rather, "the wrong type of UV". The severity of radiation damage is also dose-related. In some of the most severe cases, the lamps were positioned very close to the reptile, even at eye level, and/or aluminium reflectors were used to increase the intensity of UV in the basking area.

CURRENT SITUATION

The companies involved to date appear to be addressing the problem. Once the likely cause of the PKC was identified, both Central Garden & Pet (R-Zilla) and ZooMed Labs Inc. re-formulated their fluorescent lamps to remove "non-terrestrial" UV-B. The new products were released in September 2008 and April 2009 respectively, but remaining stocks of older versions of some of the lamps are still on sale in some areas at the time of writing (November 2009). However, the older-style ZooMed Reptisun 10.0 lamps have been pre-burned in the factory to reduce their initial output, and are being sold with revised instructions regarding minimum distances.
The number of cases brought to the attention of the current author has fallen (from 12 incidents between January and June 2009, to just 4 between July and December 2009). However, many Chinese companies are still offering cheap "reptile lamps" to small distributors wishing to sell their own brand. Spectral analysis of samples of some of these has revealed high levels of "non-terrestrial" UV-B and even UV-C. It remains essential to raise the awareness of the hazard amongst veterinarians, reptile keepers and, in particular, the lamp manufacturers and distributors.

GUIDELINES FOR SAFE USE

Guidelines for the safe use of UV-emitting lamps in the vivarium:

- Lamps should not contain any "non-terrestrial" UV-B (wavelengths < 290nm) and only a small proportion of the total UV-B should be below 300nm.
- The risks of high UV-B radiation in close proximity to any UV lamp must be understood.
- The manufacturer's recommendations regarding minimum basking distances must be suitable, advertised clearly, and followed closely.
- Aluminium reflectors may have a greater effect upon UV output than is generally realised. They are very effective, but should be used with caution.

- UV lamps should be placed in close proximity to a bright light source such as a basking light, to provide a visible indication of the radiation source and also to discourage the animal from staring directly into the lamp.
- The lamp should be positioned directly above the reptile so that it is not in the animal's direct line of sight, and its eyes are shaded from the direct beam by the eyelids and/or the shape of the head.

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Photo-kerato-conjunctivitis in reptiles

Frances M. Baines M.A. Vet.M.B. M.R.C.V.S.

case reports collected with

Dr. Michele Buono DVM, Milan, Italy

Dr. David Gardiner DVM, Colorado, USA

Dr. Brendan Carmel BVSc MVS MACVSc (unusual pets) GD, Victoria, NSW Australia

ARAV Conference 2010

6th March 2010, Munich, Germany

Photo-kerato-conjunctivitis in reptiles

- **Prior to 2006**: Occasional anecdotal reports
  : Occasional references to symptoms in animal experiments (e.g. Hibma 2004)

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2006	16
2007	94
2008	42
2009	33
2010	58

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Fluorescent lamps

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Fluorescent lamps

Mercury vapour lamps

Lamps associated with photo-kerato-conjunctivitis in reptiles

Company and Brand Name	Lamp type	Affected animals	No. of deaths
ZooMed Reptisun 10.0	Compact lamps	42	4
ZooMed Reptisun 5.0	Compact lamps	10	0
ExoTerra ReptiGlo 10.0	Tubes/ compact lamps	5	0
R-Zilla Desert 50 Series	Tubes/ compact lamps	>57	6
R-Zilla Tropical 25 Series	Tubes/ compact lamps	28	7
Ferplast UV-B 10%	Tubes	7	2
ReptaPets Australia Sun Plus UV	Tubes	20	1
ZooMed 100W Powersun	Mercury vapour lamps	8	0
ReptileUV MegaRay		45	3
T-Rex ActiveUV Heat		11	0
TOTAL		233	23

Reptiles affected include:

- Bearded dragon
- Bluetongue skink
- Chinese water dragon
- Frilled lizard
- Green basilisk
- Cuban knight anole
- Panther chameleon
- Veiled chameleon
- Crested gecko
- Yellow-headed day gecko
- Red-eared slider turtle
- Painted turtle
- Map turtle
- Yellow-foot tortoise
- Spur-thighed tortoise
- Sulcata tortoise
- Ball python
- Burmese python
- Kenyan sand boa
- Indonesian tree boa
- Honduran milk snake

Typical presentation

Within 1 – 3 days of setting up the new lamp:

- animals refuse to open one or both eyes
- avoid light and refuse to bask, feed or drink
- appear to be in pain and "depressed"

Blue-tongue skink - case AM. Lighting set-up.
Reptisun 10.0 compact lamp in right-hand dome

Blue-tongue skink - case ref. AM. 24 hours after first exposure

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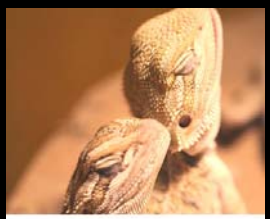

Bearded dragon hatchlings - case ref. JP (Lamp BJP1)

Bearded dragon - case ref. RW.
1st Sept. 2007 - 2 days after R-Zilla lamp removed

- more severely affected animals develop swollen eyelids
- rarely, lesions resembling burns around the eyes
- some reptiles show photophobia

Yellow-footed tortoise - case ref. FC1

Bearded dragon - case ref. JB.
Avoidance behaviour and swollen eyelids

- symptoms in turtles may resemble vitamin A deficiency

Case KS : Red-eared slider hatchling under
R-Zilla Tropical 25 series compact lamp

Case JM : Red-eared slider hatchlings under
R-Zilla Tropical 25 series compact lamp

- some reptiles become severely debilitated "overnight"

Case MG - on first day of installation of ReptileUV MegaRay MV lamp

• some reptiles become severely debilitated “overnight”

Case MG - 1 day after removal of ReptileUV MegaRay MV lamp

• some reptiles become severely debilitated “overnight”

Case MG – 3 days after lamp removed

Fatalities

• In the worst cases the skin of the body was severely “burned” as well, and death followed.

Dead Panther chameleon. Extensive skin damage on body, limbs and tail. (Photo courtesy of David Weldon)

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Dead Panther chameleon. Extensive skin damage on body, limbs and tail. (Photo courtesy of David Weldon)

Dorsum of Albino burmese python 12 days after lamp removed (photo courtesy of David Gardiner DVM)

Fatalities

• In the worst cases the skin of the body was severely “burned” as well, and death followed.

Leopard gecko - after 2 days exposure, died 2 days later. (Photo courtesy of Michele Buono DVM)

burmese python 12 days after (photo courtesy of David Gardiner DVM)

Fatalities • Debilitated reptiles - shock and dehydration

Bearded dragons - case AR. Vivarium set-up.

Prognosis

- **If lamp removed early, complete recovery in 1 – 3 days**
- **Debilitation and secondary infection may delay recovery**

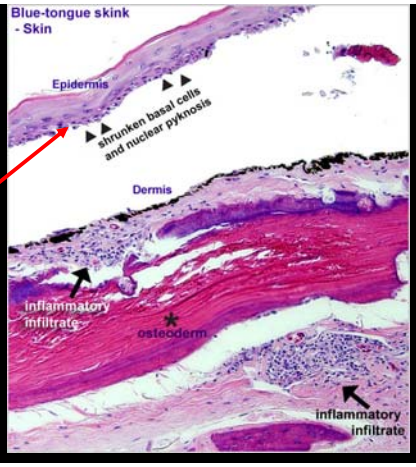
Histopathology

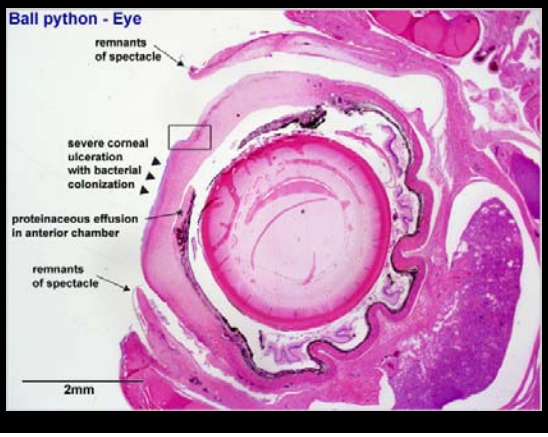
David Gardiner DVM, Colorado State University

10 reptiles under new R-Zilla T5 Desert 50 series UVB lamps.

- **PKC, dysecdysis, anorexia, lethargy**
- **No response to 3 wks antibiotics and "improved hygiene"**
- **3 died**
- **Pathologists first to suspect radiation damage**

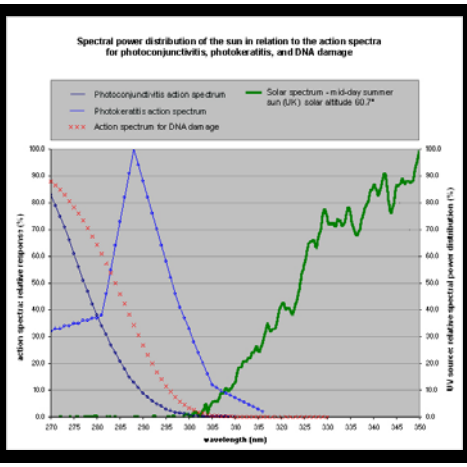
"sunburn cells" undergoing apoptosis

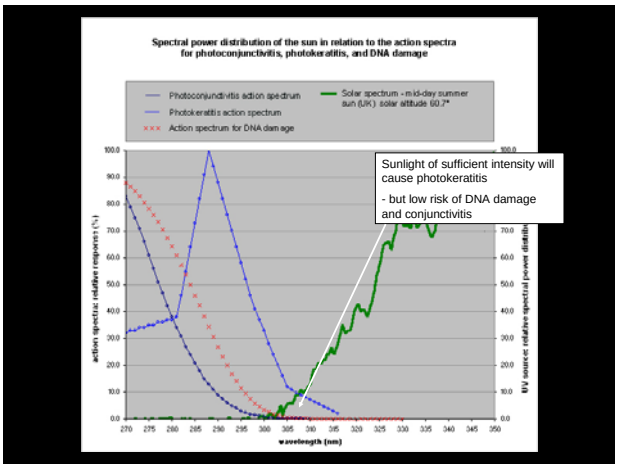


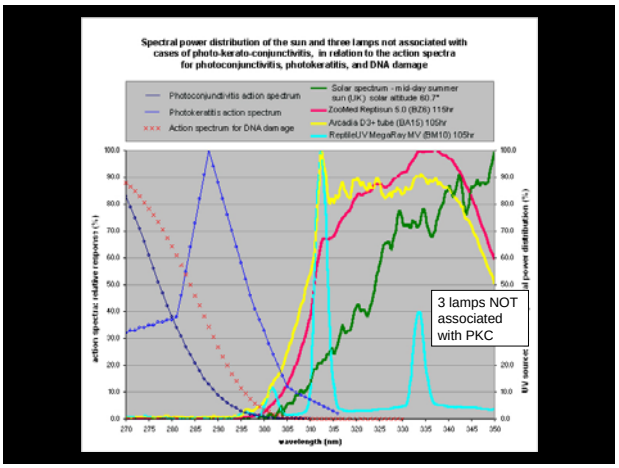


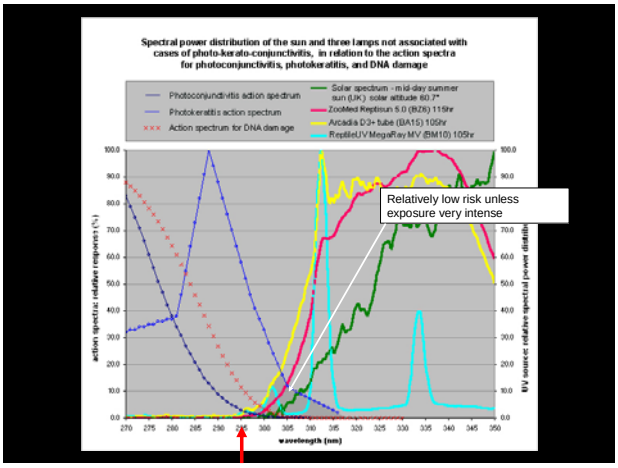
Only certain brands of lamp cause this problem…

WHY?




Spectral power distribution of the sun in relation to the action spectra for photoconjunctivitis, photokeratitis, and DNA damage
Photoconjunctivitis action spectrum
Photokeratitis action spectrum
Action spectrum for DNA damage
Solar spectrum - mid-day summer sun (UK) solar altitude 60.7°
Sunlight of sufficient intensity will cause photokeratitis
- but low risk of DNA damage and conjunctivitis
action spectra: relative responses (%)
UV sources: relative spectral power distribution (%)
wavelength (nm)


Spectral power distribution of the sun and three lamps not associated with cases of photo-kerato-conjunctivitis, in relation to the action spectra for photoconjunctivitis, photokeratitis, and DNA damage
Photoconjunctivitis action spectrum
Photokeratitis action spectrum
Action spectrum for DNA damage
Solar spectrum - mid-day summer sun (UK) solar altitude 60.7°
ZooMed Reptisun 5.0 (BZ5) 11Shr
Arcadia D3+ tube (BA15) 105hr
ReptileUV MegaRay MV (BM10) 105hr
3 lamps NOT associated with PKC
action spectra: relative responses (%)
UV sources: relative spectral power distribution (%)
wavelength (nm)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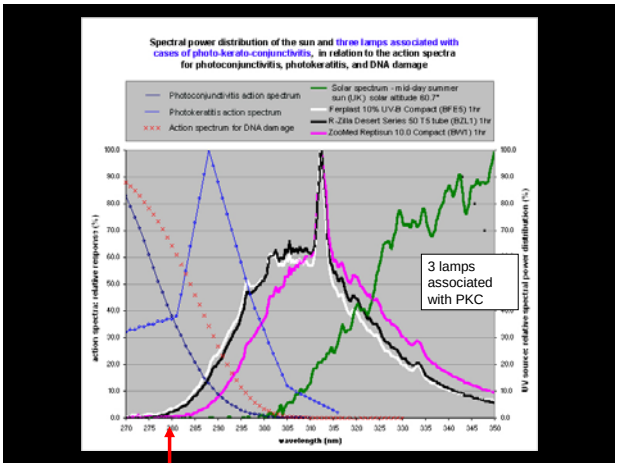
ZooMed Reptisun 5.0 (BZ5) 11Shr
Arcadia D3+ tube (BA15) 105hr
ReptileUV MegaRay MV (BM10) 105hr
Relatively low risk unless exposure very intense
action spectra: relative responses (%)
UV sources: relative spectral power distribution (%)
wavelength (nm)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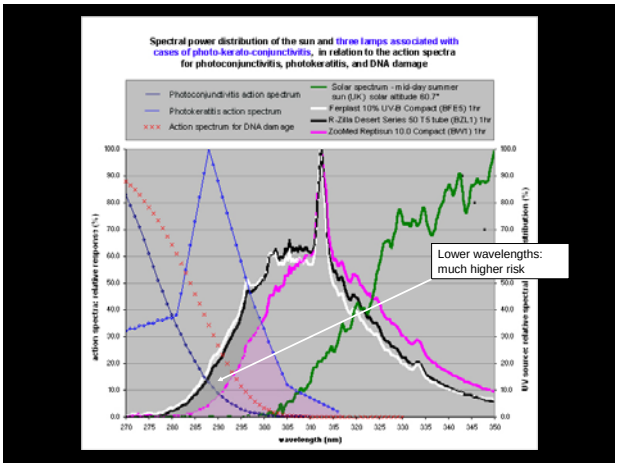
Photoconjunctivitis action spectrum
Photokeratitis action spectrum
Action spectrum for DNA damage
Solar spectrum - mid-day summer sun (UK) solar altitude 60.7°
Ferplast 10% UV-B Compact (BFE5) 1hr
R-Zilla Desert Series 50 T5 tube (BZL1) 1hr
ZooMed Reptisun 10.0 Compact (BW1) 1hr
3 lamps associated with PKC
action spectra: relative responses (%)
UV sources: relative spectral power distribution (%)
wavelength (nm)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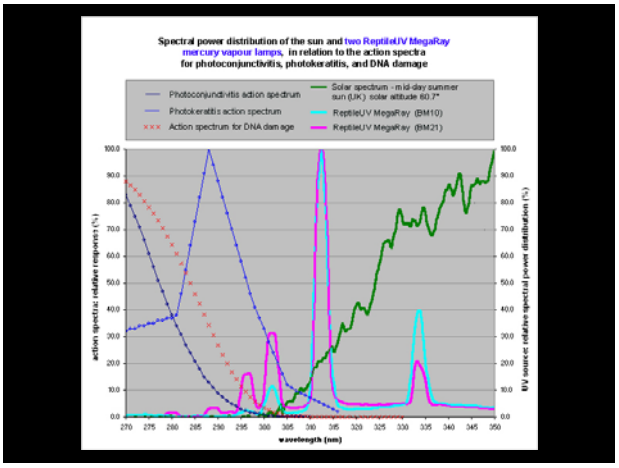
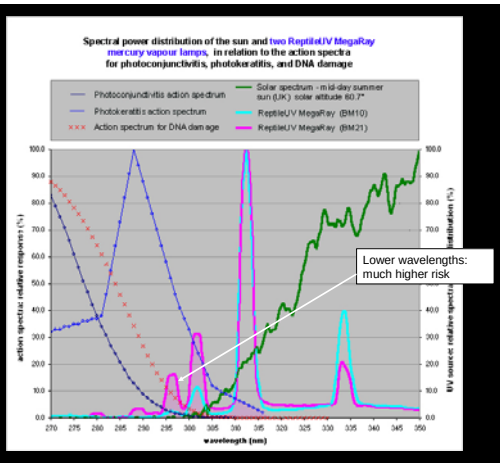
Photokeratitis action spectrum
Action spectrum for DNA damage
Solar spectrum - mid-day summer sun (UK) solar altitude 60.7°
Ferplast 10% UV-B Compact (BFE5) 1hr
R-Zilla Desert Series 50 T5 tube (BZL1) 1hr
ZooMed Reptisun 10.0 Compact (BW1) 1hr
Lower wavelengths: much higher risk
action spectra: relative responses (%)
UV sources: relative spectral power distribution (%)
wavelength (nm)


Spectral power distribution of the sun and two ReptileUV MegaRay mercury vapour lamps, in relation to the action spectra for photoconjunctivitis, photokeratitis, and DNA damage
Photoconjunctivitis action spectrum
Photokeratitis action spectrum
Action spectrum for DNA damage
Solar spectrum - mid-day summer sun (UK) solar altitude 60.7°
ReptileUV MegaRay (BM10)
ReptileUV MegaRay (BM21)
action spectra: relative responses (%)
UV sources: relative spectral power distribution (%)
wavelength (nm)



Are acute photo-kerato-conjunctivitis and skin burns the only risk ?

Are acute photo-kerato-conjunctivitis and skin burns the only risk ?

DNA damage….

…….Possible increased incidence of neoplasia?

Dr. Brendan Carmel BVSc MVS MACVSc (unusual pets) GD

Victoria, NSW Australia

Bearded dragon with cutaneous adenocarcinoma

(Photo courtesy of Brendan Carmel)

Bearded dragon with squamous cell carcinoma

(Photo courtesy of Brendan Carmel)

Bearded dragon with squamous cell carcinoma

(Photo courtesy of Brendan Carmel)

How to detect a “problem” lamp

	UV Index reading when total UVB is 100 µW/cm²
Natural UK summer sunlight	1.5 - 2
Arcadia D3 Compact Lamp	2.2
ZooMed Reptisun 5.0 tube	2.3
ZooMed Reptisun 10.0 tube	3.1
ZooMed Reptisun 10.0 Compact Lamp (2007)	9.2
R-Zilla Desert Series 50 tube (2007)	13.6
Ferplast Desert UV-B 10% tube (2007)	14.3
ZooMed Powersun MV Lamp (2007)	3.7
(2009)	8.7
ReptileUV MegaRay MV Lamp (2005- 2009)	3.6
(2009-2010)	8.5

Preventing Photo-Kerato-Conjunctivitis

1. Avoid lamps emitting “non-terrestrial” UVB (<290nm).
2. Ensure risks of high UV close to ANY UVB lamp are understood.
3. Provide a suitable UVB gradient and shelter.
4. Observe manufacturer’s minimum recommended distances.
5. Use aluminium reflectors with caution.
6. Place UVB lamp as close as possible to bright basking lamp.
7. Light sources must always be placed directly above reptiles.