UV-B Radiation and its Effects on Amphibian Declines

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WFS 433

UV-B Radiation: What is it?

- One of three types of ultraviolet radiation (UV-A; UV-B; UV-C)
- UV-B – Only type particularly harmful to living organisms
- Levels have risen significantly over last few decades
  - Stratospheric Ozone Depletion
  - Clear-cutting and habitat destruction
- Most intense in summer months
- Damages DNA, causes cell death and mutations

Blaustein et. al; 2003

UV-B Radiation = Problem for Amphibians! When?

caudata.org

All Life Stages!

frogforum.net

pwconserve.org

flickr.com

treklens.com

esacademic.com

* Particularly detrimental to embryos

Blaustein et. al; 2003

UV-B Radiation = Problem for Amphibians! Why?

- Embryo:
  - No shell
  - Eggs usually laid in shallow water or near surface/terrestrial
- Larvae:
  - Thin, permeable skin
- Adult:
  - Thin, permeable skin

Source: ecotrend.org

UV-B Radiation = Problem for Amphibians! What Kind?

Complicated!

- Lethal effects
- Sub-lethal effects: Impaired growth, slowed development, hatching success, predation risk, malformations, altered behavior, retinal damage/blindness (Searle et. al; 2009)
- Species-specific (Romansic et. al; 2009)
- Vary with life stage (Romansic et. al; 2009)
- Vary with ecological context (Romansic et. al; 2009)
- Synergistic relationship
  - Interacts with pH, contaminants, disease (Blaustein et. al; 2003)

UV-B Radiation affects embryos:

UV-B radiation severely affects embryo development in the Mexican axolotl

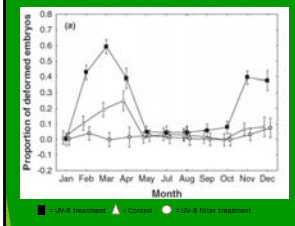
Patricia Frías-Alvarez[1], J. Jaime Zúñiga-Vega[2,*], Gabriela Parra-Olea[1]

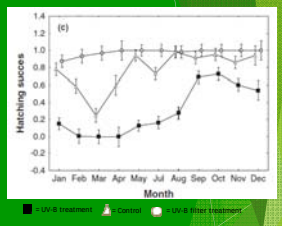
- *Ambystoma mexicanum*
- 60% decline
- Listed as Critically Endangered by IUCN
- Were exposed to 3 UV-B treatments:
  1. 99% of UV-B blocked
  2. Control
  3. Direct exposure to natural daylight (maximum natural UV-B Radiation that A. mexicanum might experience)

Source: nationalgeograhic.com

Friaz-Alvarez et. al; (2010)

UV-B Radiation affects embryos:





Friaz-Alvarez, et. al; 2010

* Without successful hatching or with high deformity rates, there is no recruitment of new individuals into a population!

UVB-Radiation affects larvae:

Experimental examination of the effects of ultraviolet-B radiation in combination with other stressors on frog larvae

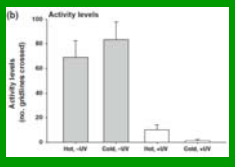
Catherine Laura Searle · Lisa K. Belden · Betsy A. Bancroft · Barbara A. Han · Lindsay M. Biga · Andrew R. Blaustein

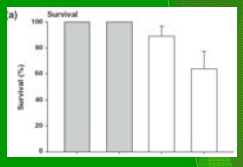
Source: whatfrogs.org

- *Rana cascadae*
- Important ecological role as larvae and adults
- Documented population declines
- Exposed to 2 levels of UV-B (Exposed and Shielded)
- Exposed to 2 temperatures (Hot and Cold

Searle et. al; (2009)

UV-B Radiation affects larvae:





- Reduced Activity
  - Decreased feeding rates
  - Smaller size at metamorphosis
  - Inability to escape predators

* Cold temperatures – reduce a larva's ability to prevent UV-B damage because repair enzymes work faster at warm temperatures

Searle et. al; (2009)

UV-B Radiation affects adults:

Behavioral Avoidance of Ultraviolet-B Radiation by Two Species of Neotropical Poison-Dart Frogs

Barbara A. Han[1,3], Lee B. Kats[2], Rachel C. Pommerening[2], Ryan P. Ferrer[2], Marcia Murry-Ewers[4], and Andrew R. Blaustein[1]

D. pumilio

Source: memozee.com

- *Dendrobates pumilio* and *D. auratus*
- No documented population declines
- *D. pumilio* considered among most abundant anuran species in lowland forests of Costa Rica
- *D. pumilio* – excellent parental care by both males and females
  - Transport tadpoles on their back to suitable locations
- Diurnal
- Perch in light gaps to maximize call effectiveness

D. auratus

Source: marietta.edu

Han et. al; (2007)

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Results:

- Both species spent significantly more time under the Mylar
- Randomly sampled sites received 6X the amount of UV-B as sites where *D. pumilio* were observed calling

Han et. al; (2007)

Putting it all together:

What does all of this mean?

UV-B Radiation is THE MOST important factor when considering amphibian declines!

- Directly and indirectly affects individuals and populations
- Lethal and sub-lethal effects
- Affects ALL LIFE STAGES!

Literature Cited:

Blaustein, A. R., Romansic, J. M., Kiesecker, J. M. and Hatch, A. C. (2003), Ultraviolet radiation, toxic chemicals and amphibian population declines. Diversity and Distributions, 9: 123-140. DOI: 10.1046/j.1472-4642.2003.00015.x

Frias-Alvarez, Patricia, Jaime Zuniga-Vega, J., Parra-Olea, Gabriela. (2010), UV-B radiation severely affects embryo development in the Mexican axolotl. Animal Biology, 60: 299-318. DOI:10.1163/157075610X516510

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Romansic, John M., Waggener, Amy A., Bancroft, Betsy A., Blaustein, Andrew R. (2009), Influence of ultraviolet-B radiation on growth, prevalence of deformities, and susceptibility to predation in Cascades frog (Rana cascadae) larvae. Hydrobiologia, 624: 219-233. DOI: 10.1007/s10750-009-9703-2

Source: soundbiteblog.com