Thermal acclimation across the active season of wild, free-living eastern red-backed salamanders

Richard Jones, Bryanna Mangual, Samantha Hall, Alexandra Gomez, Amanda Nicolaides, Louise Tichy, Keesha Dubuisson, Dan Stich & Elizabeth Bastiaans

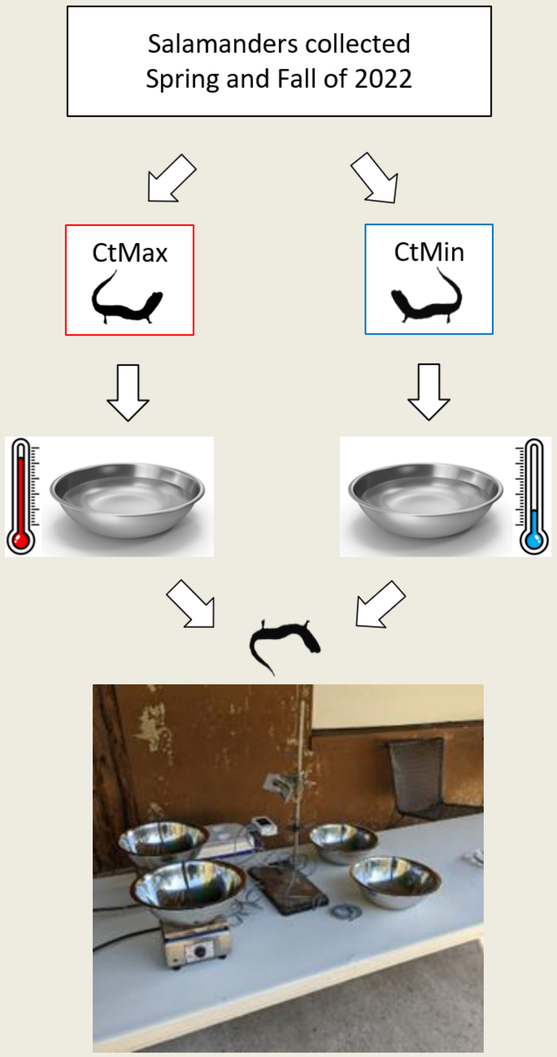
Biology Department, SUNY Oneonta, Oneonta, NY

This Photo by Unknown Author is licensed under CC BY-NC-ND

Fig. 1: ***Plethodon cinereus***

INTRODUCTION

- Amphibians are ectotherms and regulate body temperature using the external environment.
- May be vulnerable to increasing temperatures due to climate change[1][2][3][4].
- Capable of thermal acclimation[5], which may be crucial in withstanding rising temperatures.
- We examined thermal acclimation of free-living, wild red-backed salamanders (Fig. 1) to determine if the range of temperatures they can tolerate varies across their active season.



METHODS

- Salamanders were collected from College Camp, just outside of SUNY Oneonta and randomly assigned to a critical thermal maxima (CtMax) or critical thermal minima (CtMin) experimental group.
- Starting at the ambient temperature, salamanders were then exposed to a water bath that had its temperature steadily heated with a hot plate or cooled by adding ice (a change of about 1 °C every minute).
- Every 30 seconds, salamanders were flipped on their back and checked for loss of righting response to determine CtMax or CtMin[6].

RESULTS

- There was a significant effect average high temperature on CtMax ($p < 0.001$) (Fig. 2), and a significant effect of average low temperature on CtMin ($p = 0.003$) (Fig. 3).
- We found a significant effect of SVL on CtMin ($p = 0.0013$) (Fig. 4) but failed to detect a significant effect of SVL on CtMax ($p = 0.87$) (Fig. 5).

CONCLUSIONS

- Salamanders were able to tolerate higher temperatures during the warmest part of their active season.
- CtMin seems to be less plastic than CtMax.
- Smaller salamanders are more vulnerable to cold snaps.
- The duration and timing of red-backed salamander active seasons may begin to shift in response to changing temperatures[7][8].

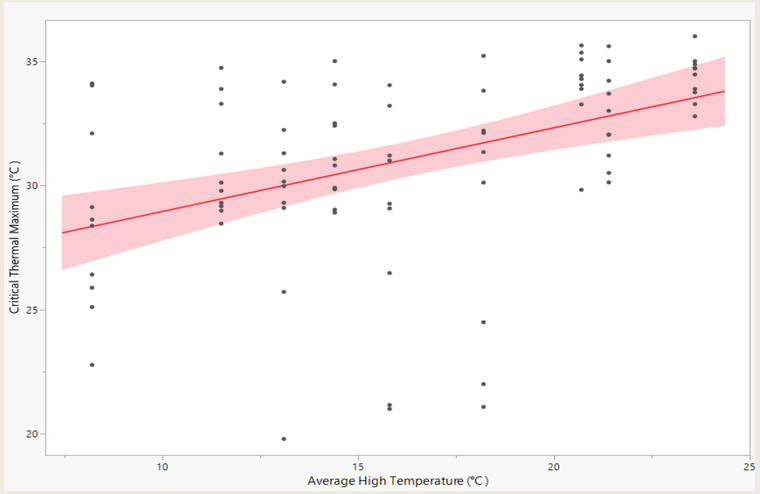


Fig 2: Effect of day on the critical thermal maxima of red-backed salamanders ($\chi 2 = 18.27$, $p < 0.001$).

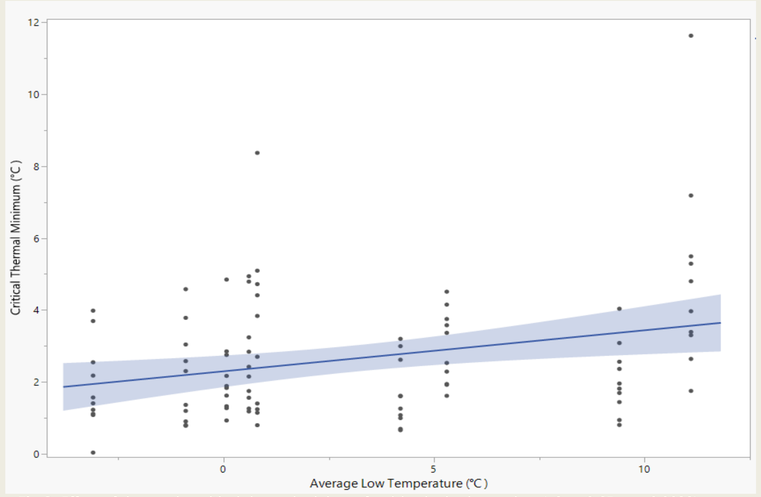


Fig 3: Effect of day on the critical thermal minima of red-backed salamanders ($\chi 2 = 8.65$, $p = 0.0033$).

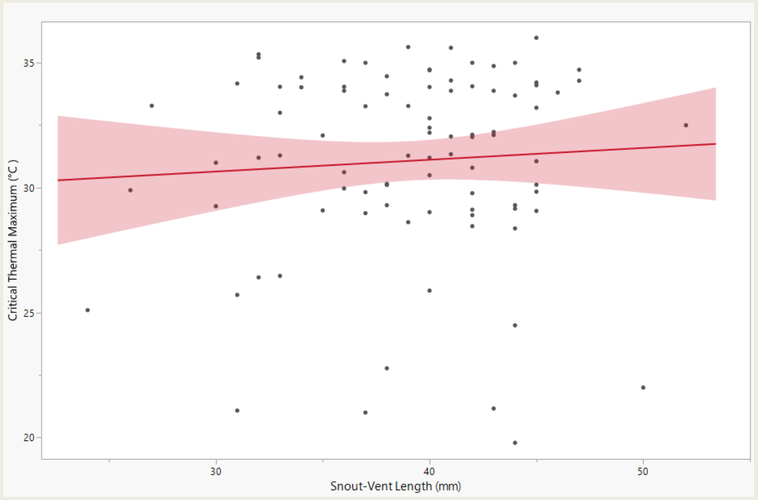


Fig 4: Effect of SVL on the critical thermal maxima of red-backed salamanders ($\chi 2 = 0.03$, $p = 0.87$).

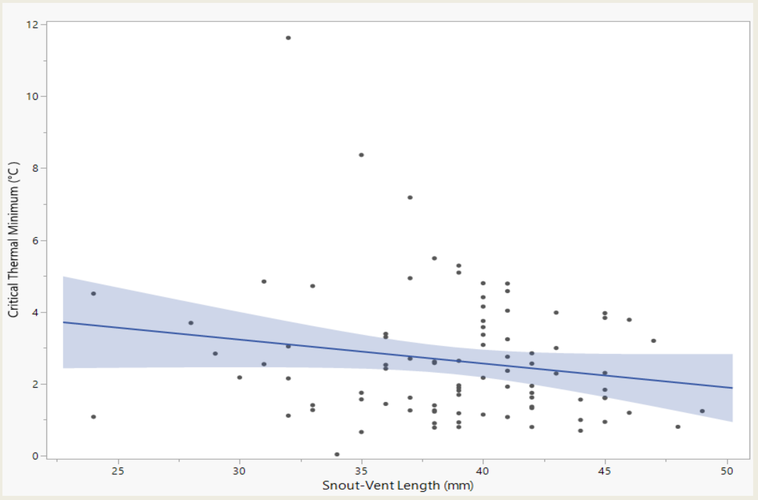


Fig 5: Effect of SVL on the critical thermal minima of red-backed salamanders ($\chi 2 = 10.30$, $p = 0.0013$).

LITERATURE CITED

[1] Beebee, T. J. C. 1995. Amphibian breeding and climate. Nature 374(6519):219–220.
[2] Houlahan, J., C. Findlay, B. Schmidt, A. Meyer, and S. Kuzmin. Quantitative evidence for global amphibian population declines. Nature 404 (May 1, 2000): 752–55.
[3] Kiesecker, J. M., A. R. Blaustein, and L. K. Belden. 2001. Complex causes of amphibian population declines. Nature 410(6829):681–684.
[4] Pounds, J. A., M. P. L. Fogden, and J. H. Campbell. 1999. Biological response to climate change on a tropical mountain. Nature 398(6728):611–615.
[5] McFarland, W. N. Upper lethal temperatures in the salamander *Taricha torosa* as a function of acclimation. Copeia 1955, no. 3 (1955): 191-194.
[6] Hutchison, V. H. Critical thermal maxima in salamanders. Physiological Zoology 34, no. 2 (1961): 92–125.
[7] Kusano, T., and M. Inoue. 2008. Long-Term Trends toward Earlier Breeding of Japanese Amphibians. Journal of Herpetology 42(4):608–614.
[8] Üveges, B., Mahr, K., Szederkényi, M., Bókony, V., Hoi, H. and Hettyey, A., 2016. Experimental evidence for beneficial effects of projected climate change on hibernating amphibians. Scientific reports, 6(1):1-7.

ACKNOWLEDGMENTS

This study was funded by a Student Research Grant from the Research Foundation for SUNY. We like to thank the SUNY Oneonta Biology Department and College Camp for the use of facilities and materials, especially College Camp caretaker Michael Hiscox. We would also like to thank Dr. Christopher Karmosky and Jacob Coffey for providing temperature data.