Temperature effects on cutaneous healing in rough-skinned newts (*Taricha granulosa)*

Sydney Greenfield, Geoff Smith, Lori Neuman-Lee, and Susannah French
Department of Biology, Utah State University

INTRODUCTION

•Immune function in ectotherms is highly temperature dependent (Wright & Cooper 1981).

•Temperature deviations outside the optimal range have been shown to alter innate immunity in some ectotherms (Dittmar et al 2013).

•We analyzed how temperature stress might affect immunity in juvenile newts.

•We also analyzed how housing newts at three different temperatures spanning the range of preferred body temperatures affected their immune response.

•For both studies, we hypothesized that temperature and healing rate would exhibit a positive relationship.

•Alternatively, newts may have an optimal temperature at which they perform best.

METHODS

•Biopsy punches were used to create small uniform cutaneous wounds on each of the newts which were then measured over a period of 15 or 18 days for adults and juveniles, respectively.

•Juvenile newts were either transferred to a different temperature (7°C) or remained at the same temperature (14°C).

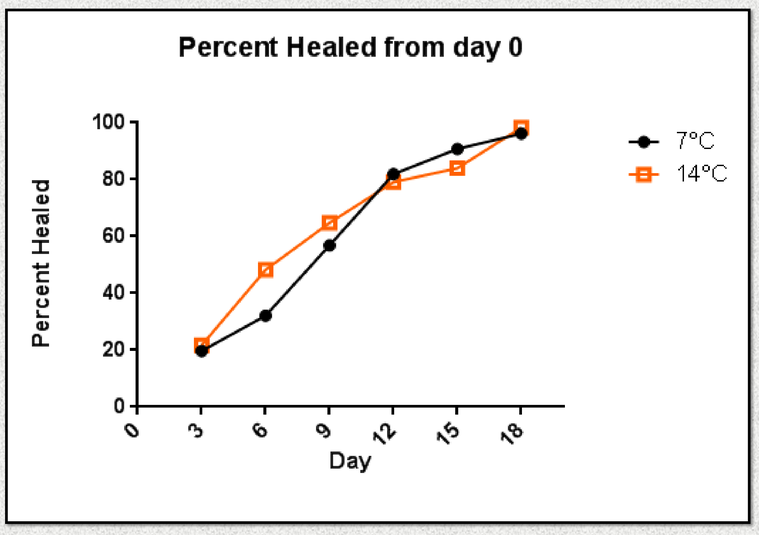
•Adult rough-skinned newts (*Taricha granulosa*) were divided into three temperature groups, 21 °C, 14 °C, and 7°C.

• Size of the wounds over time was used to indirectly evaluate immune response.

Photo courtesy of Gareth Hopkins

RESULTS

Figure 1. Juvenile newts that underwent the temperature change showed a suppressed healing response early during the primary innate immune response period (day 6), relative to those that remained at a stable temperature throughout the study.



•Adult newts housed at 7 °C mounted a greater initial immune response, followed by 21 °C, and finally 14 °C. (Figure 2).

Healing in an Adult Newt

Day 0

Day 6

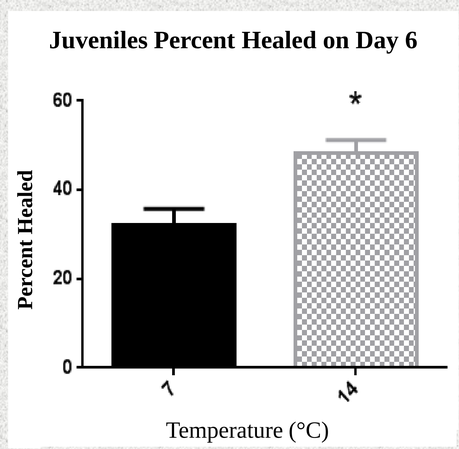


Figure 2. Juvenile newts that remained at 14 7°C had the greatest immune response

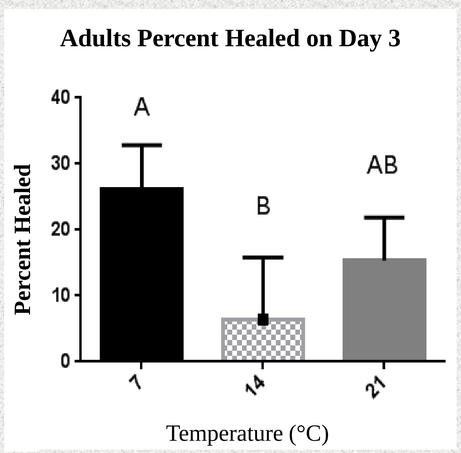


Figure 3. Adult newts had greatest immune response at 7 °C. Levels not connected by the same letter are significantly different

DISCUSSION

•There is good evidence that the immune system is temperature sensitive (Butler et al 2013).

•Interestingly, juvenile newts that were acclimated to 14 °C and then underwent a temperature stress via switch to 7 °C, showed reduced healing during the initial, stress-sensitive (French et al 2006), immune phases of wound healing.

•Results from the adult newts suggest that early during the innate immune response animals from 7 °C healed faster relative to the other temperatures.

•In either case, these results suggest immune function is heavily impacted by environmental temperature.

•Our results for adult newts are similar to those of the study on temperature stress on immunity in three-spined sticklebacks, where animals at lower temperatures resulted in greater immune response (Dittmar et al 2013).

•Finally, increased immune response at lower temperatures could be a result of varying bacterial growth in the aquatic environment, which is also temperature-dependent. It is possible that at colder temperatures, while immune response may be suppressed, bacterial growth is suppressed even further.

•These two experiments taken together indicate that other variables, abiotic and biotic, work alongside temperature to affect the overall healing profile of a wounded animal.

REFERENCES

Butler MW, Stahlschmidt ZR, Ardia DR, Davies S, Jon D, et al. 2013. Thermal Sensitivity of Immune Function: Evidence against a Generalist-Specialist Trade-Off among Endothermic and Ectothermic Vertebrates. *The American Naturalist* 181: 761-74

Dittmar J, Janssen H, Kuske A, Kurtz J, Scharsack JP. 2013. Heat and immunity: an experimental heat wave alters immune functions in three-spined sticklebacks (*Gasterosteus aculeatus*). *Journal of Animal Ecology*: Accepted Article (October 2013)

French SS, Matt KS, Moore MC. 2006. The effects of stress on wound healing in male tree lizards (*Urosaurus ornatus*). *Gen. Comp. Endocrinol.* 145: 128-32

Wright RK, Cooper EL. 1981. Temperature effects on ectotherm immune responses. *Developmental & Comparative Immunology* 5, Supplement 1: 117-22

ACKNOWLEDGEMENTS

We would like to thank Dr. Edmund D. Brodie, Jr., Gareth Hopkins, and Jory Johnson for their assistance and support.