Webinar Q&A Report:
Ecophysiological Impacts of Climate Change: Performance, Fitness and Extinction

1. If a very snowy year is followed by early snow in the next year, can that limit the number of animals who make it to adult overwintering?

   C. Williams: Yes, a late spring after a very snowy winter will reduce the length of the growing season and may mean some animals have trouble reaching the overwintering stage in time, particularly if autumn snows come early. That's why considering the full lifecycle is important, to understand how winter conditions impact summer performance and vice versa. We need a fully resolved view of the lifecycle that incorporates both the dormant and the active period, considering selection pressures across the full lifecycle.

2. Did your team collect data on humidity gradients?

   C. Williams: We have not collected data on humidity gradients, but snow does of course have an important impact on moisture content of the soil both during winter and in spring. The amount of snow will impact the quality of the willow host plants that the beetles feed on, with more snow leading to well-watered and higher quality plants. We haven't started to look at the role of the host plant quality in determining the long-term impacts of drought, but that's definitely an important area to focus on in future.

3. Do you see any evidence for evolutionary shifts in thermotolerance within this species?

   C. Williams: Demonstrating adaptive evolution in physiological traits is hard! My colleagues Nathan Rank and Elizabeth Dahlhoff have identified several genes that have strong impacts on thermal tolerances and energetics in summer, which we are currently following up on to determine their role in winter performance and fitness in snowy and dry winters. These genes vary along latitudinal and elevational gradients, and fluctuate between years in a manner that is consistent with responding to natural selection imposed by climate variation. We still have some work to do to establish that these patterns of genetic change are caused by selection on thermal tolerances, but I suspect that is a part of the story.

4. Does burrowing depth vary with elevation?

   C. Williams: We don't know in the beetle system, but Ray Huey and Michael Kearney and colleagues have been showing that burrowing depth is an important buffer against environmental variability, with deeper burrows providing protection against cold but increasing energy costs (if the ground surface is colder than the depths). Snow is likely to strongly modulate the benefits of burrowing depth, so that's an interesting question to pursue. The beetles we work on are incredibly hard to find in the wild during their winter dormancy, so it will be difficult to address in this system.

5. Do you think your results showing a difference in energy expenditure in response to climate change between birds and mammals might explain why dinosaurs went extinct whereas mammals survived the KT extinction event?

   E. Riddell: Microhabitat use clearly plays a really important role in buffering animals from climate change. The underground and generally nocturnal lifestyles of small mammals certainly helps them from rapid changes in their environment and likely contributed to their survival in prehistoric climate change. However, there are many other factors that are important to consider for small mammals, including vegetation, food supplies, and competition, which are all known to influence long term responses to climate change.

6. Do you have a sense about if resident vs. migratory birds differed in extinction probability in resurvey project and if so, might this be tied to differences dispersal physiology?

   E. Riddell: We analyzed migratory and resident birds in a separate analysis (in the supplement) but did not find any differences in the correlation between decline and cooling costs. This is likely because we focused on spring time conditions, when all species were present in the desert. Though migratory birds may have difference experience in non-breeding grounds, it appears the climate change that has occurred in the Mojave is still important to them.

7. Aren't birds also known to upregulate ceramides and other waterproofing molecules when subjected to dry conditions? (Similar to what you found with the Salamanders?)

   E. Riddell: Yes! This is true, as well as mammals. Ceramides appear to be a universal way to waterproof the skin.

8. What would be the advantage of the salamanders becoming 'leakier' during wet periods? (Why not just be non-leaky year-round?)

   E. Riddell: It's important to be leaky because salamanders need to maintain wet skin to breathe. With moisture on the skin, oxygen can dissolve into the liquid and then diffuse across the respiratory surface. In this case, it's the skin but the same is true for your lungs.

9. Aren't the projected values of skin resistance for future (between 8-15 s/cm) too high for salamanders? Mainly when considering a 3g wet-skinned salamanders.

   E. Riddell: Nope. These were based on empirical observations in the laboratory. Thus, we know salamanders can achieve this skin resistance during acclimation studies.

10. Are there any indications that these traits vary in any sort of pattern when considering the closely related plethodontids that are much more aquatic?

    E. Riddell: We have no idea! It would be a great project to explore.

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