# Frozen frogs: How amphibians survive the harsh Alaskan winters

7 January 2014, by Shane Hanlon

As winter approaches, many of us hunker down and virtually "hibernate" for the season. Classic hibernation in the wild conjures images of furry bears, but other animals are not so lucky to have immense fat stores or fur to protect them from the elements. Frogs that live at northern latitudes have neither of these, but must find ways to survive the harsh winter season. Their solution? Freezing…but not to death.

Wood frogs (Lithobates sylvaticus) freeze upwards of 60% of their bodies during the winter months. "For all intents and purposes, they are dead," said Don Larson, a Ph.D. student at Fairbanks who is interested in how frogs in some of the harshest conditions of Alaska alter their physiology to survive the long and extremely cold winters. Unlike previous studies, Larson used standard lab-based experiments, but also included measurements to track a population in the wild.

Beginning in October, Larson tracked frogs throughout the harsh winter season. Prior to freezing for the entire season, he observed that frogs underwent 10-15 cycles of freezing and then thawing. Thinking that such freeze/thaw cycles may be the key to the frogs' survival through the winter season, Larson wanted to mimic these natural conditions back in the lab. To do this, he conducted a lab experiment where frogs were left unfrozen, frozen directly, or frozen through a freeze/thaw cycle.

In the wild, all frogs survived throughout the long winter where temperatures ranged from -9°C to -18°C, a longer and colder period than previously observed with wood frogs. How did they avoid becoming frog-flavored popsicles? One clue was the amount of glucose in the frog's tissues, one of the primary agents that "protect" the frogs while they freeze. In both field and lab settings where the freeze/thaw cycles occurred, glucose concentrations increased between 2 and 10-fold, levels that have never been previously observed.

Glucose production occurs as frogs begin to freeze. Thus, Larson thinks that the high number of freeze/thaw cycles allows for a greater increase in glucose production. This process is akin to the deliberate hyperventilation of divers prior to submerging, which serves to increase the volume of air that their lungs can consume. The frogs' version of hyperventilation—the freeze/thaw cycles—increases their glucose levels to allow them to survive longer and colder conditions.

While previous research has shown that wood frogs can tolerate low temperatures for short periods of time, frogs in Larson's study survived longer, had a higher incidence of survival (100%), and survived at colder temperatures than ever previously recorded. Moreover, his work highlights glucose as an agent for the survival of wood frogs in the harsh winter conditions. Now that Larson has a better understanding of how a frog's physiology changes in response to the winter season, his next step is to understand how things living inside them, such as parasites, will be affected. He hopes to use his current research to shape future studies that examine the role of the cold environment on host-parasite interactions in frogs.

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