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Cold-weather frog research surpasses limits

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FAIRBANKS — If it quacks like a duck, well, it might just be a wood frog.

"Here, listen to this," graduate student Don Larson pulls out a recorder and turns it on.

A bird-like warble echoes in the office at the University of Alaska Fairbanks Arctic Health Research Center.

"That's a wood frog. A lot of people think they sound like ducks."

Most of us don't give frogs a second thought. Especially in the throes of our frigid, northern winters. But wood frogs in Alaska, even up north, are underfoot, and frozen during the coldest, darkest months.

New research at the Institute of Arctic Biology shows that wood frogs in Alaska can freeze for about seven months and emerge in the springtime ready for action, sans freezer burn.

The frogs actually freeze and thaw during the earlier cold months, generating glucose in their bloodstream, which keeps them alive through a process scientists call cryoprotection. The glucose essentially stabilizes cells and prevents them from drying up. Until very recently, research has shown that they can freeze for a short time, but Larson and his research have proved otherwise.

"Before we put out this paper, we didn't really know the lower limits to freeze tolerance in wood frogs," said Larson, the lead author of the study, in his office last week.

"This is very exciting."

Larson's initial goal through his research, which was funded by the National Science Foundation, was to study parasites and how they handle the winter. And to do that, he needed to study the parasites' host.

Enter the frogs.

"To understand what the parasite is doing, I have to understand its environment, and its environment is its host," Larson explained.

Although wood frogs are well-studied freeze-tolerant amphibians, Larson's research is believed to be the first to examine the frogs under natural conditions. He also observed the frogs in the lab and was later able to compare the two.

Larson discovered that when wood frogs are outside in their natural environment they accumulate much higher concentrations of glucose in their tissues than frogs frozen in a lab.

"They pack themselves with glucose," Larson said. "They get extremely sweet. They increase their glucose level 100 times almost; it's a ridiculous amount pumping through their body. If it were us, we'd be in a diabetic coma."

Glucose concentrations in the outside frogs were 13 times higher in muscle tissue, 10 times higher in heart tissue, and 3.3 times higher in liver tissue compared to lab-frozen frogs.

Before the research began, Larson thought the coldest temperature a wood frog could survive was around 19 degrees

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Fahrenheit, and for only around two months.

Various other research papers in Canada showed that wood frogs could only freeze for a few days or weeks at a time because of the temperature fluctuations during the winter.

"But that's not what happens up here," Larson said. "It gets cold, and it stays cold. We'll get down to negative 40 or 50."

Wood frogs dig down into the duff and leaf litter, creating a winter habitat. Snow insulates the ground, which keeps the temperature around zero Fahrenheit, he added.

Of the 18 frogs that Larson studied over two years, all of them survived outside on the research grounds at UAF.

"This is lower and longer than previously predicted or even imagined. We didn't expect this kind of survival."

The reason that the frogs studied outside, versus in the lab, produce so much more glucose and are therefore surviving colder temperatures for a longer period, is that frogs outside will freeze as the temperature drops on autumn nights but then thaw out during the day. That freeze-thaw cycle helps them generate more glucose than the frogs in the lab, which are frozen gradually.

Larson and co-author Brian Barnes, the director of the UAF Institute of Arctic Biology, videotaped the wood frogs to observe their behavior as they were preparing for their frozen hiatus. The amphibians were active until right around the freezing mark, Larson said.

"Winter is just not a barrier to these guys, like we thought it would be."

Wood frogs are found across the state, even up north of the Brooks Range with unconfirmed reports of sightings on the North Slope. Wood frogs are the only amphibian found in Interior Alaska, Larson said.

So what does all this mean for us?

Well, for one, the feat of freezing frogs may one day have an application in the science of human organ transplantation.

"This means that large animals, like us vertebrates, are capable of surviving, our cells are capable of surviving, in a frozen state longer than we previously believed," he said. "The applications for us, though, are distant future ones. But if we can keep wood frogs frozen for these long periods of time, is it possible we can keep organs for transplant, or even people, frozen."

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