

# Amazing frozen frogs

Right now, in shallow pools and wet woodlands in Adams County, wood frogs (*Rana sylvatica*) can be heard croaking in chorus for mates. They are the earliest frogs to appear in the spring, often before the ice is off the water. Besides living in Adams County, wood frogs can also be found in eastern North America all the way up to the Arctic Circle. Wood frogs even call from arctic tundra pools. How can these wood frogs survive freezing winters?

Dr. Jon Costanzo, a professor from Miami University, Ohio, and a researcher in Miami's Laboratory for Ecophysiological Cryobiology ("cryo" means low temperature), has been studying wood frogs in Adams County for the past 19 years. He's been fascinated with how these amphibians survive the winter just below the leaf litter in a shallow depression which they have dug.

According to Dr. Costanzo, "In order to survive the coldest of winter temperatures, wood frogs freeze solid. Their heartbeat stops and all bodily functions cease. They can remain in this state for a few days to a month." In other words, the wood frogs could be considered dead. But are they? Once spring arrives, the frog's heartbeat will spontaneously start again. The frog will unfreeze and become fully functional within 14 to 24 hours and be ready to mate immediately.

How do these frogs do it? Dr. Costanzo says, "The process starts when ice touches the frog's skin in winter. This immediately sets off signals inside the frog's body to pull excess water away from the organs and cells. The remaining water then freezes." The problem with freezing is that ice crystals and concentrated salts can damage cells. The frog uses a cryoprotectant (antifreeze) made of glu-



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cose (a kind of sugar derived from the liver) to solve this problem. The cryoprotectant lowers the freezing temperature inside the cells so that water only freezes in between the cells. The cryoprotectant also helps the cells by preventing dehydration. Remember, the remaining water in its body has been frozen solid and unavailable to the frog.

According to Dr. Costanzo, "In early spring, the frog's heart, which lost 50 percent of its water during freezing, amazingly resumes beating even though more than 30 percent of the frog's internal water is still frozen. After the heart begins beating, the frog starts to rehydrate and regain its reflexes." Finally, the frogs make their way to wet pools to mate.

Many people ask Dr. Costanzo if this method of freezing and coming back to life can work on humans. It cannot. "Although cold is used in organ transplants, the organs are never frozen. Furthermore, the freezing of an entire organ system in a human and bringing it back to life is impossible," says Dr. Costanzo.

Wood frogs aren't the only frogs in Adams County that can survive freezing in this manner. The spring peeper, gray treefrog, mountain chorus frog, and Cope's treefrog are all freeze tolerant. So the next time you see or hear a wood frog, imagine what the little guy went through this past winter.



☐ Pictured above is a frozen wood frog taken by Evelyne Davidson, Miami University Laboratory for Ecophysiological Cryobiology.