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## **Frogsicles and Other Winter Adaptations**

As we enter late November, reptiles and amphibians are now ensconced in their winter quarters, oblivious to the punishing weather and absence of food. Like our mammals, they, too, call upon a number of different strategies to survive until spring.

Contrary to popular belief, not all species of frogs head to the bottom of ponds and wetlands with the onset of cold weather. Instead, a many species actually overwinter in forests and woodlots, usually with only a thin blanket of leaves between them and zero degree weather. They essentially become tiny blocks of ice. This group includes the spring peeper, chorus frog, gray treefrog and wood frog. Thanks to some ingenious adaptations, the freezing process does not harm the animals.

With the onset of cold weather, species such as the wood frog burrow several centimetres down into the leaf litter. As outside temperatures drop, the frog's metabolism slows to a crawl and its body temperature approaches 0C. However, when the first ice crystals begin to form on the frog's skin, an alarm reaction is set off. In a response somewhat similar to the "fight-or-flight response" in humans, adrenaline is released into the bloodstream. The adrenaline in turn activates enzymes that convert glycogen in the frog's liver to glucose. Blood glucose levels soar to astronomic concentrations - levels that would kill a human many times over - and before the ice reaches the cells, they, too, become packed with glucose. The glucose acts as a very effective antifreeze, inhibiting freezing from occurring within the cell itself.

In body cavities outside of the cells, special proteins actually promote the freezing of fluids. Pockets of concentrated fluid are created and through osmosis, even more water is withdrawn from the cells. This, in turn, further increases their resistance to ice formation. Even though more than half the water in the frog's body may be frozen, there is no damage done to the cells of the internal organs.

Within only 15 hours, the frog becomes frozen solid. During the many months of suspended animation, there is no breathing, blood circulation or heartbeat. By most definitions, the frog is essentially dead. However, when researchers have dug up these "frogsicles" and let them thaw out, the frogs became active again with less than half an hour. When you consider that these species not only spend the winter frozen, but then wake up in the spring ready to sing their hearts out and partake in a full-fledged mating frenzy - and all on an empty stomach! - it gives you a new appreciation for the resiliency of life.

Green frogs, mink frogs and bullfrogs have taken a different approach to enduring the rigours of winter. All three species overwinter in the mud at the bottom of ponds and marshes. They are able to take in the little oxygen they need directly through their skins. Leopard frogs, however, usually prefer moving water which provides more oxygen. They often migrate to streams and rivers in the fall. It is not uncommon to see diving ducks on the Otonabee River come up with a hibernating leopard frog that they have plucked from the river bottom.

True to its many unfrog-like characteristics, the American toad has opted for a different option for dealing with cold and famine. The toad retreats to below the frost line, either by burrowing down into loose soil or by taking up winter residence in ready-made burrows or crevices. This allows it to escape temperatures below freezing. It has also been show that toads keep on digging deeper over the course of the early winter, staying just ahead of the

ever-deepening frost line. They stop digging when the soil temperature remains at 1C to 2C above freezing. This of course becomes their body temperature. Gardeners sometimes find toads when turning soil in the fall.

Snakes, along with terrestrial salamanders like the blue-spotted, must also descend below the frost line in order to survive winter. Rodent burrows and crevices in rocks are both common hibernacula. Many snake species move to these sites during cool weather in October, although the garter snake may wait until well into November. It is not uncommon to find different snake species using the same winter site. This may be explained by the scarcity of good sites. There are also reports of garter snakes hibernating in cisterns and even being immersed in water.

As for aquatic turtles, most have opted for the same strategy as pond-dwelling frogs. Turtles winter at the bottom of lakes, rivers and wetlands. By extending their head and legs in an effort to expose as much skin as possible, hibernating turtles are able to take up dissolved oxygen from the water. However, snapping and painted turtles usually burrow into the mud of the pond bottom, a milieu which is nearly devoid of oxygen. This would seem to indicate that the oxygen requirements of these two species during the winter are almost nil.

The turtles eventually enter a state of deep hibernation. Their physical lethargy and low body temperature reduces their resting metabolism to a point where their heartbeat can slow to less than one per cent of the summer rate. This allows them to survive for extended periods of time, even when almost all of the oxygen in the water has been used up. As Bernd Heinrich in "Winter World" asks, "What is death to a turtle? What is being alive? For six months it stays under ice water, buried in mud, where all breathing, movement, and presumably almost all heart activity stops. In spring it comes up, warms up, takes a few breaths, and resumes life where it left off."

As I was mentioning several weeks ago, many baby turtles adopt the "freeze solid" strategy and actually overwinter in the nest. After hatching out of the eggs in late summer, they simply stay put, and do not emerge from the ground until April. As with treefrogs and peepers, freezing is limited to body cavities outside of the cells. This is a one shot affair, however. By their second winter, the young turtles must overwinter in the same manner that adults do.

Obviously, the ways in which amphibians and reptiles survive cold and famine challenge the limits of our beliefs about what seems biologically possible. These adaptations are true medical marvels and, I'm sure, make some people dream about putting themselves on ice to be reawakened again at some future date!

What to watch for this week:

Bald eagles should be arriving in the Kawarthas any day now. Watch for them around lakes, especially Stoney, Jack and Katchewanooka. The Kawarthas have become known as one of the best places in Ontario to see eagles in the late fall and winter.

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