Nature Note by Andrea Howard

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Winter Survival

Ontario may not boast the brilliant diversity of colourful creatures that populate the warmer climes, but we have a dizzying diversity of brilliant adaptations to winter – almost as many stories as there are animals.

What's the problem with winter?

The problem with winter is ice. Unique in the physical world, water occupies more space in its solid state (ice & snow) than it does in its liquid state. On the one hand, this is a life-giving phenomenon. If water followed the way of other elements and became denser in its solid state, ice would not float and water bodies on the planet would freeze from the bottom up, obliterating all life therein.

That said, there is the other hand. Like our planet, we living beings are mostly water. If ice crystals form inside body cells, they may take up more space than is available and rupture organelles or the cell membrane, killing the cell. Frostbite is a manifestation of this: blackened fingers and toes indicate tissue death at the cellular level and a major problem for the victim. A more common manifestation is the fractured pop-can on the porch.

Animals and plants have therefore evolved innumerable ways to avoid tissue damage and freezing to death. There are those who thrive, those who leave, those who stay and tough it out and those who 'sleep' right through it.

Hibernation

The 'sleeping' strategy has traditionally been referred to as hibernation (from the Latin *hiber*, meaning "winter"), with a distinction made between "deep" and "shallow" hibernation. Technically, the term is now reserved for the animals that undergo extreme metabolic change to induce a deep, catatonic, sleep-like state. You may see other terms, such as dormancy, torpor, or torpidity to describe the shallower sleep. By the way, some animals who love the cold are programmed to sleep through the summer, aka to estivate, from the Latin *aestas*, meaning "the hot season". Similar in their processes, these strategies are also responses to oxygen deprivation.

Warm-blooded animals (aka homeotherms and heterotherms)
Let's begin our survey with warm-blooded animals – those who have the capacity to regulate their internal temperature. Raccoons, skunks, and porcupines find cozy sanctuaries in which to sleep through very cold periods, waking occasionally on warmer nights to forage for food. Like us, they shiver and may huddle together to keep themselves warm. Chipmunks reduce their body temperature quite drastically in sleep, suggesting deep hibernation, but they must awaken every few days to raise their body temperature by moving around. They will urinate and defecate in an area separate from their sleeping chamber; they will also eat from the *cache* of food that they have, um, squirrelled away in yet another chamber, in the underground labyrinth that is their realm.

By contrast, bears do not eat, defecate, or urinate during hibernation. They do, however, remain wakeful, able to respond to danger if it approaches. The physiological processes that hibernating bears undergo are quite astounding. The Yellowstone site of the US National Park Service features excellent scholarly research about bear hibernation in various climatic zones. Authors dub bears "super-hibernators" due to the elaborate environmental and metabolic strategies they employ to decrease their body temperature and metabolize their fat stores, recycling urea into nitrogen to build protein and to maintain organ tissues. As they lose fat, they may even increase lean-body mass. High cholesterol levels do not cause them arteriosclerosis or even gallstones. In fact, "the bear's liver secretes a substance that dissolves gallstones in humans without surgery". [Oh-oh. Let's not be bleeding bear livers!] "Another mystery of hibernation is that bears do not lose bone mass during hibernation. All other mammals which maintain non-weight bearing positions for an extended period of time suffer from osteoporosis, or a weakening of the bones. When the substance responsible for this phenomenon is discovered, it may help people who suffer from weak bones."

Another cool thing that happens during a bear's hibernation is birth, but only if the mother-to-be's body is well prepared for the process. I went to Alaska with my Mum years ago and learned about an amazing adaptation in Alaskan Brown Bears, aka Grizzlies. A female bear may mate in the spring, but the fertilized egg or eggs do not implant in the uterus just yet. Mamma bear must eat a great deal over the summer and fall months to build up a good layer of fat for a healthy hibernation. When that is the case, the egg(s) will implant, and she will bear one to three cubs mid-winter and nurse them throughout the rest of her hibernation. The young family will emerge in the spring, and she will keep her cubs near her through another year, including their next hibernation. If, however, times have been tough and she has not succeeded in building up enough fat stores, the fertilized eggs will simply be absorbed by her body, and she will not bear young that year. Astounding!

Groundhogs are true hibernators in their underground dens. The emergence of Wiarton Willy and Punxsutawney Pete on February 2nd is a rude awakening, to be sure. Any self-respecting Groundhog is out like a light 'til spring.

Bats are true hibernators. They ought to remain asleep in their caves throughout the winter but can be awakened by sudden temperature changes and other disturbances, such as loud noises and excessive light, even. The food energy they accumulated before hibernation is not needed while they sleep, since their metabolism is fairly shut down, but it is needed for arousal in the spring. Every time the bat is disturbed to the point of waking, some of that stored energy is lost. Three unscheduled alarms in a winter can be enough to so weaken the bat that it will not survive. Another stressor is White-Nose Syndrome – a fungal disease that has killed millions of bats across North America – the hardest hit being the Long-eared, the Little Brown and the Tricolored, according to the folks at White-Nose Syndrome.org. The WNS Response Team maps the progress of the disease across the US and Canada, where records began in 2009. First detected in New England in 2006 and found on sick and dying bats in Albany NY in 2007, the fungus grows on the exposed skin and causes the bat to become active, burning up the fat needed to survive its hibernation. It is thought that hunger might then drive the bat out of its cave to look for food. Doing so in the dead of winter is obviously a death-sentence. Though the fungus has been found in Europe and Asia, bats there do not appear to be as endangered by it. The spores live a long time on surfaces and can be picked up by bats in their environment. Responsible spelunkers and mammologists – professional and amateur – take precautions to avoid transporting the spores from cave to cave on their clothing and equipment.

We can all do our part to protect bats. White-Nose Syndrome.org suggests building bat houses and provides instructions, encourages monitoring and reporting findings about local populations [good ole' citizen-science], and reducing disturbance to natural bat habitats around our homes, for example, reducing outdoor lighting, minimizing tree clearing, and protecting nearby streams and wetlands. This seems to be good advice for protecting all manner of wildlife!

Moving on to mammals who tough it out and remain wakeful, each has its own adaptations for survival. Snowshoe Hares grow white fur to replace their summer brown. With our changing climate, I have been concerned about these bite-sized beacons on a snowless grey landscape, but I recently acquired a hare-pelt that is slate gray. Evidently the gray fur grows in before the white. Whew!! Camouflage works! Meanwhile, the welcome snow also protects smaller mammals like mice and voles from four-legged predators and insulates the plant and invertebrate life they feed on.

All wild mammals grow thicker fur or hair in winter. Many congregate in groups to generate heat. (I daresay domestic animals do the same!) Sensitive noses find edible plant life and lichens well refrigerated under a blanket of snow, but life is tough for herbivores great and small, and many do not survive. A degree of migration also happens for mammals: into the woods for the deer, where the snow is less deep; into dens, logs, empty tree trunks (snags), caves and underground tunnels. Also, let's not forget, into houses!

Deep snow is not such an issue for the hare's principal predator, Canada Lynx, whose paws are big and wide like snowshoes. Nor are owls deterred. With what I call their 3-D hearing, they can pinpoint a mouse under a foot of snow as easily as if they could see it. Ruffed Grouse plunge and tunnel into snowbanks and startle the dickens out of passing skiers when they burst out of their hiding place. They grow extra feathers around their nostrils and on their legs and feet. The feet feathers, called pectinations, increase the surface area of the foot to enable walking on snow.

Many birds avoid the cold altogether by flying south. We bid them farewell on their perilous journeys and hope they will dodge the hurricanes and high-rises and return to us next spring. For some Boreal Forest birds, like Snowy Owls, Evening Grosbeaks and Gray Jays, now officially our Canada Jay, we are the south! Our warm-blooded feeder friends have fluffed up with winter feathers and may lower their body temperature to make it through cold nights. Many have incorporated helpful humans into their adaptation strategies. The Black-capped Chickadee hides my gifts of sunflower seeds in slivery cedar bark and fenceposts. A discarded Christmas tree in the back yard can provide shelter for feeder birds throughout the winter and contribute nutrients and biomass to our gardens and lawns.

Cold-blooded animals (aka poikilotherms or ectotherms or exotherms)
Now, on to cold-blooded animals, whose body temperature is naturally the same as the ambient temperature that surrounds them. These animals might avoid, control or even permit freezing in their bodies.

Among the avoiders are the migratory butterflies – not in the least limited to Monarchs. According to thebutterflysite.com, the Painted Lady, Common Buckeye, American Lady, Red Admiral, Cloudless Sulphur, Skipper, Sachem, Question Mark, Clouded Skipper, Fiery Skipper and Mourning Cloak are all butterflies that migrate southward in the fall! Wow!

Some amphibians and reptiles can avoid freezing without leaving home, though they may migrate a short distance to seek appropriate shelter. They then enter a hibernation state akin to that of mammals, by drastically slowing their heart rate and respiration.

American Toads, salamanders and snakes avoid freezing by migrating underground, below the frost line. Clawless, they slip between rocks, follow tree roots or venture down tunnels dug by burrowing mammals. If vehicles crash around the woods off-road, wheels compact the soil and vibration can cause these precious tunnels to collapse and prevent entry and exit. Please stay on the trails! Amphibians will mate in temporary 'vernal pools' left behind by melting snow next spring.

Most turtles, Bull Frogs and Green Frogs prefer to sink down into deep liquid water for their winter sleep. Leopard Frogs will brave the highways on warm, rainy days in autumn, in one of their three annual migrations. They prefer to spend the winter in the well-oxygenated, flowing waters of large streams and rivers. In the spring, the first warm rainy nights will bring them out of the river by the thousands, driven to migrate to inland ponds and wetlands, to the still waters they need for mating and egg-laying. Oh! the carnage! Mid-summer, the young frogs will travel into fields, lawns and gardens to hunt their insect prey. In England, hundreds of concerned citizens have joined patrols to usher migrating toads and toadlets across hazardous roads. Perhaps we can start a Leopard Frog posse to protect the many who cross our River Roads.

"Freeze-tolerance" in amphibians is particularly interesting. The Wood Frog and our three treefrogs are capable of this: Chorus Frog, Spring Peeper and Gray Treefrog. They will spend the winter nestled in a soft, dry hiding place, above-ground – in leaf litter, up a tree in a crotch or a notch, in a cattail mat – protected from physical harm during their frozen slumber. They might thaw out occasionally if it gets too warm, but they can "refreeze" multiple times. The physiological process is fascinating, involving dehydration of body cells and controlled freezing of interstitial fluid. World renowned Carleton University scientist, Doctor Kenneth Storey, his wife Janet and a succession of PhD students research a diversity of hibernation processes, with a view to eventually finding a way to preserve human organs. I visited the Storey Lab in person, some 15 years ago. So cool! One can visit it online but the site is not "secure" so I'll let you navigate there on your own; start with Ken at https://en.wikipedia.org/wiki/Kenneth_B. Storey. It was Dr. Storey who first discovered freeze-tolerance in juvenile Painted Turtles. They hatch in early fall but stay underground where their mother deposited her eggs in a second summer laying. They remain nestled in a matrix of frozen soil 'til they emerge in spring. (Beware road graders, little turtles!!) These are the only reptiles known to date who can tolerate freezing.

The term applied to most insect life that survives our winter is "super-cooled". These creatures flood their tissues with sugars to lower their freezing point. They are like ice cream or maple syrup, safe and squishy down to -35 degrees C. Super-cooled bugs make a sweet, protein-rich winter treat for insectivorous birds and mammals.

Among the tough-it-out clan, European Honeybees stay very busy in their hives, beating their wings and moving constantly to generate heat. Woe be the ones stuck on the perimeter and woe-er be the bee who steps out for a pee. These tidy insects do not fowl their hive and many do not return from the outdoor "lav" alive!!

Springtails, aka snow fleas (*Hypogastrura nivicola)* are tiny arthropods, no bigger than an eyelash. They are all-important 'detritivores' – chewing up fungi and decaying plant matter in the leaf litter under a deep, insulating blanket of snow. On warm sunny days, they migrate to the surface to breathe fresh air, warm their bodies in the sun, feed on blue-green algae and, most importantly, to mate. They are followed to the surface by their predators: hardy hunting bugs, Snow Spiders (*Lycosidae* and *Tetragnathidae* families), Snow Stoneflies (*Capniidae* family) and Snow Scorpionflies (*Boreidae* family). Notice what looks like pepper sprinkled on damp snow and look closer to watch the snow fleas leap about. You might find that you, too, want to leap for joy, as spring may be just around the corner.

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