LIVING

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Shiver their feathers

Birds, and other wildlife, have tricks to deal with bitter cold

When we experience frigid temperatures like those that descended upon us last week, it's hard not to marvel at the many adaptations of animals and plants that get them through this punishing season. Today, I'd like to take a look at how some birds, mammals and trees cope with winter.

OUR CHANGING SEASONS
Drew Monkman

When it comes to winter bird survival, feathers are the first line of defense. They provide very efficient insulation to warm avian bodies, protecting them from the much colder surrounding air. A group of small muscles controls each feather and can both raise and lower it. Using these muscles to fluff up their feathers, birds create countless tiny air spaces that drastically reduce heat loss. This is the same principle that explains why down ski jackets are so warm.

Birds can further reduce heat loss by burying bare body parts into their feathers. For example, they will often tuck their bills into their shoulder feathers. As for their legs, waterbirds will often sleep with one leg held tightly up against the body. Birds also have an amazing network of blood vessels in their feet and legs that minimizes heat loss. Warm arterial blood moving towards the bird's feet passes through a network of small passages in close proximity to the cold venous blood returning to the heart. The system acts like a radiator. Heat is exchanged from the warm arterial blood to the cold venous blood in such a way that heat loss is minimal. The lower parts of the feet are warmed just enough to stop them from freezing.

Unless they are generating heat through flight, birds must also continuously shiver to keep warm in cold conditions. This happens even while the bird sleeps. Shivering produces heat at an amazing five times the bird's normal base rate. However, when you consider that a small bird needs to maintain its core body temperature at about 42C, and that the surrounding air may be more than 70C colder, a great deal of fat must be burned to fuel the shivering process. Therefore, the most important line of defense for a small bird is to get enough to eat during the day in order to maintain fat reserves. A chickadee, for example, only has enough fuel to get through a single night. If it is not able to feed the following day, it will die.

Some birds can actually adjust their internal body temperature downward. This serves to reduce the difference between the bird's body temperature and air temperatures, thus further reducing heat loss. Less shivering is necessary and fat reserves are used up at a lower rate.

A chickadee, for instance, can lower its core temperature from 42C to 30C during a long winter night. The bird actually enters a state of torpor and becomes temporarily unconscious.

The choice of the proper sleeping quarters is also important in protection from the elements. Most songbirds, like cardinals, blue jays and mourning doves, find appropriate sleeping quarters in dense thickets of vegetation that afford shelter from the wind. Evergreens are especially popular with birds. It has even been shown that the dominant birds in a flock tend to roost in the deepest, most sheltered parts of the tree, while the least dominant birds are relegated to areas more exposed to the wind. This is why every bird-friendly backyard should include some evergreens.

Karl Egressy photo

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Birds such as the chickadee (above) have many interesting adaptations to cope with the rigours of winter.

Some birds such as the white-breasted nuthatch (left) use tree cavities as sleeping quarters

Chickadees, nuthatches and bluebirds are also known to take shelter in tree cavities and even nesting boxes at night. They will sometimes huddle together, thereby sharing their own body heat. On several occasions, I have even seen a chickadee whose tail is still crimped from a night spent squeezed in some tight hollow. However, sometimes it just gets too cold, and birds do freeze. Bluebirds seem to be especially vulnerable.

The ultimate shelter seeker, however, is the ruffed grouse. These birds will actually hurtle themselves into snow drifts for the night and become completely enveloped by the snow. Snow, of course, is a very effective barrier against extreme cold. Occasionally, a cross-country skier or snowshoer will be caught off guard when a grouse explodes out of the snow.

As with birds, mammals can also thank evolution for providing the with a variety of means to deal with cold and lack of food. Some species become completely dormant, others simply sleep for extended periods but awaken regularly, while yet a third group carries on with life pretty much as usual.

Only a few mammals, such as groundhogs and jumping mice, use the complete dormancy strategy. During its five month hibernation period, a groundhog's heart rate falls from 100 beats per minute to only 15 beats; its body temperature plummets from 35C to 6C, and its breathing is reduced to one breath every six minutes!

A second group of mammals simply sleep for extended periods during the winter months. However, they maintain near normal body temperatures and awaken frequently. Chipmunks, for example, spend the winter in their network of underground chambers. They sleep for two or three days, awaken to have a snack in a chamber where they diligently stored food during the fall, take a bathroom break in another chamber, and then return to their sleeping quarters. Raccoons and skunks do not store food but rely mostly on body fat for survival. In preparation, both species feed heavily in the fall. However, when temperatures drop below freezing, raccoons and skunks will sleep for long periods. For their winter quarters, raccoons will choose abandoned burrows, hollow logs, culverts, and even buildings. Skunks usually prefer a chamber in the ground such as an old groundhog hole. They will also take refuge under man-made structures. Both of these species may become active again during mild spells.

Bears, too, sleep away the winter but can easily be awakened. A sleeping bear's body temperature decreases only a few degrees. Its heart rate, however, slows down substantially. In addition, bears don't have to drink or urinate while in this state of "torpor." They essentially shut off their kidneys. If we were to do this, metabolic waste, mostly urea, would accumulate in our blood and poison us. Amazingly, dormant bears are able to biochemically recycle urea from their urine back into protein. In this way, even though they are not exercising, no loss of muscle tissue occurs. Another amazing adaptation is that hibernating bears do not appear to suffer from any signs of osteoporosis (loss of bone mass), even after months of inactivity. Clearly, there are research implications here for improving human health and fitness.

Many small mammals remain active during the winter by taking advantage of snow cover. Because air is trapped amongst the snowflakes as they fall, snow provides excellent insulation. In fact, the temperature under a blanket of snow does not usually fall below freezing. In addition, the heat from any animals under the snow is trapped in what amounts to a cozy "igloo." Small mammals, such as mice, shrews, and voles, are therefore able to remain active as they search for plant and animal food in a network of tunnels under the snow.

Black squirrels, too, are active all winter long, except on the coldest days. When cached acorns or bird-feeder offerings don't suffice, watch for them feeding on keys, high up in Manitoba and Norway maples. It is also possible to see them entering and exiting their well-insulated tree nests (dreys) which provide critical shelter on cold winter days and nights.

Trees also have to survive the cold. Why is it that they don't freeze solid? As it turns out, all trees actually do have a measurable "killing temperature." This is the temperature at which ice crystals form within cells, causing cell death. Killing temperatures vary, depending upon the species. This is one reason why certain species cannot survive in more northerly areas. There are even differences between populations of the same species, and among different parts of the same tree.

Protection from freezing can happen in several ways. These processes occur at the cellular level and involve the physical properties of water. One mechanism works like antifreeze in your car. Trees are actually able to concentrate sugars in their cells to lower the freezing point of any water that might be present. They are also able to move water from inside their cells and relocate it between cells on tissue surfaces. In this way, when the water freezes and expands, it doesn't burst the cells.

Formation of ice in a cell can also be prevented by an amazing process known as "supercooling" of water. In order for an ice crystal to form, a nucleus such as a grain of dust or some other impurity in the water must be present. Once an initial ice crystal has formed, other water molecules lock onto it causing rapid growth of ice crystals. However, when water is absolutely pure, it can actually be cooled to 38 degrees C without freezing. Some tree and shrub species have absolutely pure water within their cells and can therefore avoid the formation of any damaging ice.

Next week, I'll look at how reptiles, amphibians and insects manage to survive the winter season.

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