WILLIAM ERVIN

Mastering Winter

Students in a winter ecology course adapt to the harshest season by learning how animals behave when the temperature drops.

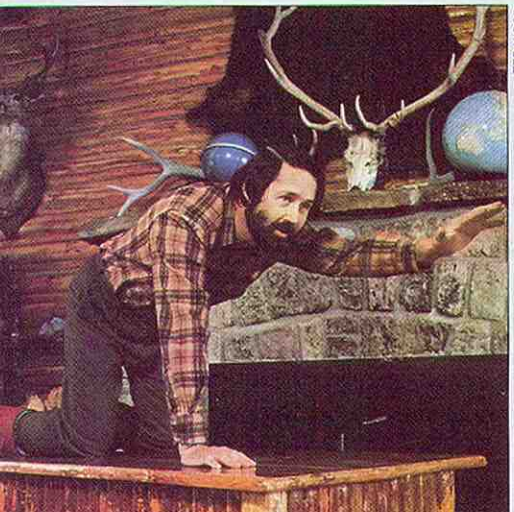
BY FRANK LOWENSTEIN

SYSTEMATICALLY MOST OF US EXCLUDE winter from our lives: We clear snow from streets and sidewalks, shop in enclosed malls, even patronize tanning salons. We pass through winter like tourists visiting a third world country, learning just enough of the language to get by. Then we retreat to the comfort of centrally heated homes, ski lodges, or, if we're adventurous, fiberfill sleeping bags.

For those who want to reach beyond their limited winter phrase books, the Teton Science School offers a course in the language of winter. For two weeks 20 adults take up residence in the school's wood-heated cabins on Ditch Creek, a small tributary of the Snake River in Wyoming. There they eat, speak, study, and live winter. They ski and snowshoe at the eastern edge of Grand Teton National Park, following trails of mice and weasels beneath the snow, examining willows cropped close by moose, and tracking muskrats and martens. By course's end, the students can converse adequately, if not fluently, with the native animals, who have learned to adapt to cold and snow.

Like a language teacher who won't allow English in the classroom, instructor Jim Halfpenny emphasizes his formula for understanding winter: "Think like an animal." Halfpenny is one of the premier animal trackers in the nation, and a founder of the National Outdoor Leadership School's (NOLS') winter program, which takes people into Yellowstone or Wyoming's Wind River Mountains for two-week stints.

While some animals avoid winter entirely by hibernating, flying south, or storing enough food to last until spring, others simply modify their behavior to suit winter's marginal conditions. "Winter is basically a time of starvation," explains Halfpenny. "The question is, does spring arrive before the animals starve to death?" While not seeking to trade places with a slowly starving moose, Halfpenny's students attempt to understand the



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Instructor Jim Halfpenny shows how a moose lifts its legs to move in deep snow. Winter herds also pack down snow to facilitate movement.

JOHNNY JOHNSON / DRK PHOTO

Clockwise from top: Bears try to avoid winter by adding up to 400 pounds of fat and holing up in a den; unable to reach snow-covered grasses, a young bull elk forages on exposed woody plants; a raccoon returns to its home at the base of a hollow maple; a bison finds limited shelter beneath a pine.

DANIEL J. COX

TED LEVIN PHOTOS

instincts that help animals cope with the harshest season.

Each winter the glacier-honed hills and broad river terraces on either side of Ditch Creek metamorphose into a rounded landscape of soft and unpredictable whiteness. Animals that we consider purely terrestrial—coyotes, elk, porcupines, and weasels—must live in or atop three feet or more of snow. While this frozen blanket spells disaster for some species, it saves others from death by freezing or predation.

When snow first falls, its crystals range in shape from familiar six-sided flakes to needles, prisms, and indistinct granules. Protuberances and bumps prevent the crystals from collapsing when they collect on the ground, thus forming tiny air pockets within the snow cover. Ice crystals compose only about 10 percent of the volume of new-fallen snow; the other 90 percent is air.

These air spaces provide vital insulation and protection for small mammals. The meadows surrounding Teton Science School are crisscrossed with the tracks of bounding weasels. Periodically these tracks stop at neat holes in the snow, which lead to snow-covered networks of tunnels and nests used by the voles and mice that the weasels prey on.


DWIGHT KUHN

These small animals have a large area of skin relative to their weight; they can't carry enough fur to prevent hypothermia. A mouse with fur as thick as that of an arctic fox would be an immobile and vulnerable ball of fluff—tunnels beneath the snow are a small mammal's substitute for a down parka. In dry years, when these animals are deprived of the snow's insulating blanket, populations just drop, says Halfpenny.

While enabling small mammals to survive, new snow can cause problems for animals that live on the surface. Coyotes, foxes, and wolves that are lithe during other seasons move slowly through deep powder, sinking up to their bellies with every bound, expending large amounts of energy in their struggles. Because high energy output requires massive food consumption, and because food is scarce in winter, these canines try to avoid moving through deep powder, often holing up until conditions improve.

Other animals, however, are able to move over or through even the fluffiest snow. Lynx and snowshoe hare sport large feet that spread their weight over a large area. Humans adopt the same strategy by using skis or snowshoes.

Large animals rely on long legs to carry them through the deep white stuff. In this regard the moose is the true champion. It can lift a leg up out of the snow to chest height, push it forward without dragging, and then place it down again, much like a high-stepping horse. Deer and elk, on the other hand, drag their hooves even in shallow snow. When surrounded by deep accumulations, they keep to trails, gradually packing the snow down to form easily negotiated highways. These anatomical differences show up in various animal trails: Moose tracks sink deep, but are separated by unbroken surfaces, while deer and elk tracks show the drag of a hoof even in much shallower snow.

As snow settles, winter's challenges change. The snowflakes' protuberances begin to break off, their shapes become steadily less recognizable, and the amount of air between crystals decreases. This reduces the snow's insulating properties, and movement across its surface becomes easier.

This is bad news for deer, elk, and even moose, which must now contend with an environment more favorable to their predators than to them. While they continue to sink into the compacting snow, coyotes, wolves, and cougars move quickly over it. Surface crust caused by wind or repeated melting and freezing can compound the problem for the big animals. They repeatedly break through the crust, an exhausting process that can mangle their forelegs, sometimes even exposing the bone.

Beneath the snow's surface, another set of changes may be under way. Because snow insulates the ground, ground temperatures typically stay warmer than air temperatures through much or even all of the winter. Consequently, the air between snow crystals near the bottom of the snowpack is warmer than the air between snow crystals near the top. The warmer bottom air tends to remove water from the surrounding ice crystals and then rises, carrying water out of the lower layers. Over time these lower layers form a type of snow known as depth hoar, which consists of large, loose crystals. This weak snow forms perfect highways for mice and weasels.

In addition to mimicking the strategies of lynx and hare for moving through snow, humans can adopt the strategy of mice for staying warm in it. One morning at the Teton Science School, the class troops outside to build quinzhees, a type of snow shelter that originated in North America's subarctic forests. There, as in much of the United States, snow depths are generally insufficient for building snow caves, and the snow isn't crusty enough for an efficient igloo constructed of icy snow blocks. To


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A coyote hunts and dives after its rodent prey (above); bighorn sheep search for exposed vegetation (right); students monitor air temperatures outside and in a quinzhee (below right); deer mice inhabit well-insulated tunnels. (below left).

STEPHEN J. KRASEMAN / DRK PHOTO

build the quinzhees, the students shovel snow into two mounds about six feet high and nine feet across. Mixing the warmer lower layers with the colder upper layers causes the water vapor in the snow to freeze and harden in its new position. Later in the day, the students hollow out the mounds to form two dome-shaped shelters. The temperature inside the quinzhees may be 40 to 60 degrees Fahrenheit warmer than outside, and each sleeps three to four people.

The next night, student Shawn O'Brien becomes the guinea pig in a scientific experiment. He spends the night in a quinzhee with temperature probes on and in his sleeping bag, under his sleeping pads, and in his rectum. "I'll do anything for attention," he jokes. Although O'Brien sleeps on one open-cell foam and two ensolite pads, and doesn't use an exceptional sleeping bag, he loses more heat through the pads to the snow below than through the sleeping bag to the air above. Halfpenny suggests that heat losses from O'Brien's face, which is uncovered and therefore uninsulated, might double the loss. The experiment seems to prove that ground pads and face coverings, rather than thicker sleeping bags, are the keys to winter comfort.

The experiment raises a larger question. "Why do we care whether we're hot or cold?" muses instructor Roy Ozanne. Why should we become incoherent, weak, and sleepy when our temperature drops from 98.6 degrees to 88.6?

The problem begins with the chemical bonds that hold our bodies together. Most of these bonds are covalent, which are difficult to break down except at high temperatures, as in a fire. Our bodies use enzymes to sever these bonds and to derive energy without high temperatures. This is the basic mechanism by which we convert sugars into mental or physical activity. In cold temperatures these covalent bonds become stronger, and enzymes have a harder time breaking them down. Moreover, many enzymes get their shape from what Ozanne calls "weak" bonds. Low temperatures disrupt these bonds, creating misshapen enzymes that may not work at all.

Not only enzymes are affected. At colder temperatures hemoglobin molecules are less able to release oxygen. Hence, when one's face gets cold the blood flowing through it remains oxygenated and therefore bright red. This accounts for the red cheeks and noses that many of us sport during winter.

Then there are our cell membranes, which maintain the chemical levels that allow our nerves and muscles to work. When the membranes cool, their fat congeals, much like cooking oil left in a refrigerator. This, Ozanne explains, leaves "big holes like Swiss cheese right through the membrane." Our muscles and nerves, out of chemical equilibrium, their enzymes disrupted and energy levels low, quit working efficiently. The result? Weakness, disorientation, irrational decisions—the symptoms of hypothermia. All mammals and birds are similarly affected by cold.

To prevent this problem, mammals and birds try to maintain their body temperatures within a fairly narrow range. Large mammals accomplish this primarily by maintaining a steady intake of food; a moose will happily consume 50 pounds of willow twigs and sage each day during the winter months. Small mammals, which can neither generate as much metabolic heat as moose, nor carry enough insulation to retain the heat they do generate, regulate their temperatures more actively by using miniature snow caves.

Experimenting with transmitting thermometers implanted in mice, the course instructors discovered that a mouse forced to move across the snow will run until its body temperature drops from about 98.6 degrees to about 90 degrees, then burrow into the snow for a few minutes. Once its body temperature rises, it resurfaces and runs a few more meters before burrowing again.

Windchill also affects an organism's

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temperature. In a 15-mile-per-hour wind at a temperature of 20 degrees Fahrenheit, people lose about 1,150 kilocalories per square meter of exposed skin per hour. Most people expose only their faces outdoors, which cuts the loss to about 345 kilocalories, or, as Ozanne continues nonchalantly, nearly two candy bars per hour. He goes on to make a pitch for wearing facemasks—either that, or stocking an endless supply of candy bars.

After a week in the classroom, the students are ready to tackle field research full-time. Each student chooses a project. Al Nowicki, a graduate student at the University of Wisconsin, follows the myriad weasel tracks that crisscross the meadow. Where they disappear beneath the snow, he starts digging. Late afternoon finds him lying on his side, only his dark wool cap visible above the snow. He is peering into a one-inch-high hole, trying to figure out the weasel's next move without collapsing the tunnel. He points across the meadow to where a pile of snow marks an earlier effort. "That one got so complicated I gave up," he says.

Meanwhile, Joe Austin, a NOLS instructor, tromps through the woods examining porcupine feeding patterns and trying to determine how animals choose trees. Other students study insects in spruce galls, moose distribution along the creek, and acclimatization of human feet to cold.

MICHAEL H. FRANCIS

An elk's death becomes a coyote's meal.

One night a restlessness takes hold of the group, perhaps rebellion at a bit too much learning, perhaps inspired by the full moon and the clearing skies. "Sometimes," notes instructor Jim Ebersole, a botanist at Washington's Evergreen State College, "it's time to leave all the scientific equipment and go for a nice hike." Thus, a group of five takes off to ski up Cottonwood Creek.

Covered with snow and lit by the full moon, the spruce forest bordering the creek seems conjured up by a wizard. Speeding through it, looking for animal tracks, the five skiers gradually develop their own snow coats, hoar flakes forming on hats and hair. To the west, the mountains rise up in broken slabs, climbing toward a pinnacle that appears to lean out over the valley.

With each passing minute temperature estimates drop. Some argue for ten above while others say ten below. After 20 minutes of hard skiing, the group puts on warmer clothes, and everyone agrees that it's well below zero. Trees crack in the frozen silence. When the tale reaches the breakfast table the next day the estimates hover at 30 below. The five skiers recount with mock pride their adaptation to the conditions: Ski like mad for two and a half hours, then beat a hasty retreat home. After this jaunt, it is easy to appreciate how animals deal with nature's cycles. While these skiers rely on Gore-Tex, polypropylene, and other technological crutches, underneath their garments they've all begun to think like animals. ■

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