

## A Bear in its Lair

*Although its den provides little protection from the elements for a Minnesota winter, a black bear has a 99 percent chance of seeing spring*

by Lynn Rogers

Winter is the season of highest mortality for most northern mammals. But not for black bears, which are masters of winter survival. Their winter death rate of less than one percent is their lowest of the year.

Once considered not true hibernators because of their high body temperatures in winter, black bears are now known to be highly efficient hibernators. They sleep for months without eating, drinking, urinating, or defecating. Hibernators with lower body temperatures, such as chipmunks, woodchucks, and ground squirrels, cannot do this. These other mammals must awaken every few days, raise their temperatures to over 94°F, move around in their burrows, and urinate. Some of them must also eat and defecate during arousals. Black bears, however, develop far more insulative pelts and have lower surface-to-mass ratios than the smaller hibernators. As a result, the bears' body heat is lost very slowly, enabling them to cut their metabolic rate in half and still make it through winter, maintaining temperatures above 88° — within 12 degrees of their normal summer temperature. This, in turn, means that a black bear can react to danger faster than most other hibernators whose body temperatures may be less than 40°. New knowledge of hibernation processes has led biologists to redefine mammalian hibernation as simply a specialized, seasonal reduction of metabolism concurrent with the environmental pressures of food unavailability and low environmental temperatures.

In northeastern Minnesota, where I have studied black bear behavior and ecology since 1969, bears commonly go for seven months without eating — from mid-September until mid-April. To do that and remain in good condition requires changes in physiology, and some of these changes create conditions in bears that would cause problems in people. How bears remain healthy in winter, and how their adaptations may be used to improve human medicine, have recently become subjects of study at some of the leading medical research centers in the country. For example, bears that are living off their fat have cholesterol levels more than twice as high as their summer levels and more than twice as high as the cholesterol levels of most humans. Yet bears have no known problem with hardening of the arteries or with the formation of cholesterol gallstones. Medical studies have shown that bears in winter produce a bile juice, ursodeoxycholic acid, that may help them to avoid problems with gallstones. When given to people, this acid dissolves gallstones, eliminating the need for surgery. Black bears also greatly reduce their kidney function in winter. They do not urinate for months but still do not poison their bodies with waste products such as urea. The urea is somehow broken down and the nitrogen from it is reused to build protein. This ability to build protein while fasting allows the bears to maintain their muscle and organ tissue throughout the winter. They only use up fat. Evidence is accumulating that the physiological changes that occur in hibernating black bears are controlled by hormone-like substances. These substances also produce hibernation-like effects when

injected into other species - both other hibernators and nonhibernators, suggesting possible uses in human medicine.

Hibernation for the black bear, as for other mammals, is primarily a mechanism to conserve energy through seasons of no food or water. The process, however, does not work in summer. If there is insufficient food in summer, bears lose weight and starve, much as we would. In northeastern Minnesota, summer is practically the only season with enough of the right foods for bears to gain weight. In other seasons, the right foods are either lacking or so scarce that the bears lose weight. Grass, which bears eat in great quantities in the spring, is not easily digestible. Black bears in my study area begin to fatten up for winter in June, with the ripening of carbohydrate-rich berries. The bears' weight gains in summer depend mainly on the availability of good crops of blueberries, cherries, wild sarsaparilla berries, and hazelnuts. When these and other digestible foods disappear in September, energy conservation becomes the rule until the following May or June.

One exception to this rule concerns bears that are miles outside their usual home ranges when food becomes scarce in the fall. They have to expend considerable energy returning home for winter. A 450-pound, eleven-year-old male that was 119 miles from home on October 15 made the trip back in nine nights, going straight to a den. A second way in which black bears expend, rather than conserve, energy in the fall is by preparing a different den each year. Why they do this – often with the den of the previous year still intact - is anybody's guess. In one case, a fifteen-year-old pregnant female with access to two rock caves she had used in previous winters chose instead to build a nest above ground. (In February of the same winter this female and her newborn cubs became the first radio-monitored black bear family to be killed by wolves.)

For their dens, the black bears I observed generally chose burrows, caves, rock crevices, hollow trees, or excavated depressions under fallen trees or brush piles. A few bears simply built nests on the surface of the ground. Hollow trees were uncommon, but seemed to be preferred for dens because they probably provided the best insulation and protection from hunters and predators. Entrances to underground dens or tree cavities faced in all directions – here the bears had no discernable preferences. The entrances usually were just large enough for the occupant to squeeze through, opening into a chamber that was typically two and a half to five feet wide and two to three feet high. The distance from entrance to bear was usually two to five feet, but in some cases as much as fifteen feet.

Temperatures in the dens depended on snow cover – the bears, with their low metabolisms, did little to warm the space. In winters with several feet of snow, den entrances were often covered and temperatures inside were only slightly warmer than the soil, a few degrees below freezing. In winters with light snow, den entrances remained open and temperatures in the dens were about the same as that of the outside air, frequently 60° below freezing. Open entrances were more common. Those dens acted as windbreaks, but provided little other insulation.

The main insulation for a bear in winter is its fur, which more than doubles in insulative value during the fall. The fur is thickest on the back, neck, and sides and thinnest on the muzzle, legs, and underside. A hibernating bear sleeps in a curled-up position so that its crown is against the den floor and its nose is near its tail. This position minimizes a bear's surface area and reduces

heat loss from the thinly furred areas. For extra insulation, bears sleep on a nest of leaves, grass, and other material that they rake into the den. These nests also insulate cubs from the ground.

Females usually give birth to two or three cubs every two years; cubs are born in January, weigh less than a pound, and have practically no hair at first. She licks them to clean them and to stimulate defecation. She eats their feces and moves into position to facilitate nursing. She keeps the cubs warm and dry and usually responds to their cries.

The cubs do not hibernate. They suckle and sleep snuggled warmly against their mother's sparsely furred underside and reach weights of four to eight pounds by the time they leave the den at three months of age.

The bears under study usually spent considerable time in the fall gathering nest material and arranging it in their dens. Most of them arrived at their den locations well before snow covered the nesting materials, usually in late September or early October. (One arrived on September 2.) After digging a burrow or depression or renovating a rock cave that another bear had used in years past, the bears spent most of their time resting in and around the den or gathering nest material until they entered their dens to stay, usually in late October. Whenever cedar trees were present, bears stripped the fibrous bark from them to use in making nests. The narrow strips of bark, up to several feet long, make a durable bed that does not partially disintegrate and lose insulation value by spring in the way that beds made of finer materials such as leaves, grass, and clubmoss often do. These less sturdy materials were generally the only ones available, however, and so most nests were built with them. A few bears waited until snow covered the ground to start the work of creating a nest, but these were mainly bears that had access to an unusually long-lasting food supply, such as acorns, mountain ash berries, or garbage. They either did not make nests or made them of conifer boughs that they bit from trees.

From September 29 through October 18, 1972, Steve Wilson, Leon Konz, and I worked in shifts around the clock, watching a family of bears settle in for the winter. During the previous week, the animals had completed a burrow under the roots of a fallen pine and with all three cubs (of the previous winter) helping their mother, had begun to rake up bedding from a fifty-foot radius around it. The cubs raked leaves, grass, and forest litter, backing toward the den as they pulled piles of material with their front paws. The five-year-old mother did the same, but in addition, she bit branch tips from willow bushes and pulled up supple Labrador tea plants with her teeth, dropping them on her own piles. She also took charge of arranging all the nest material in the den. The cubs could have done a good job of this, too, as orphaned cubs have demonstrated, but the mother had her own ideas about the nest. Twice she scooped all the material out of the den, sending it flying backward between her hind legs and then putting it back her own way. Except for these vigorous remodeling jobs and instances when the cubs quickly grouped behind their mother after hearing a strange noise, all the actions we saw during this period of den preparation were languid and listless. There was no play. The bears were active only during the day, and during the three weeks of observation the activity decreased from a few hours per day to a few minutes before ceasing altogether.

The activities of these bears followed about the same daily schedule as those of a captive black bear in Alaska whose heart rate Ed Folk of the University of Iowa monitored by telemetry. That

bear, too, was active mainly by day as it neared the hibernation period. For most of each day in early fall the bear's heart beat between fifty and ninety times per minute, then for most of each night, while the bear rested, its heart rate slowed to between forty and fifty beats per minute. As fall progressed, that bear began sleeping for more and more of each day. By December, when monitoring ended, its sleeping heart rate had gradually declined to as few as eight beats per minute. This heart rate was as slow or slower than that of most low-temperature hibernators.

Even in hibernation, the captive telemetered bear retained a remnant of its day-active schedule. For a portion of most days, the bear's heart speeded up to more than forty beats per minute, and the animal was wakeful enough to lift its head if the room lights were turned on. Wild bears in northeastern Minnesota also tend to be day active, and most of those I visited in dens were wakeful enough that they lifted their heads and looked at me. Although, in general, they seemed less sensitive to danger than they had been in summer, some were moderately aggressive. A few did not wake up even during several minutes of gentle prodding and jostling, however. In one case, on March 27, 1970, I accidentally fell on a six-year-old female in her den. She didn't wake up for at least eight minutes even though her cub bawled loudly and I began gently prodding her. I wondered if the different receptions I got from the bears reflected differences in their heart rates at the times I happened to visit them. On calm days I could hear the rapid, strong heartbeats of alert bears from the entrances of their dens, but I could not hear the soundly sleeping ones.

On January 8, 1972, I tried to hear the heartbeat of a soundly sleeping five-year-old female by pressing my ear against her chest. I could hear nothing. Either the heart was beating so weakly that I could not hear it or it was beating so slowly I didn't recognize it. After about two minutes, though, I suddenly heard a strong, rapid heartbeat. The bear was waking up. Within a few seconds she lifted her head as I tried to squeeze backward through the den entrance. Outside, I could still hear the heartbeat, which I timed (after checking to make sure it wasn't my own) at approximately 175 beats per minute. This heart rate during arousal is even higher than has been recorded for very active bears.

Research scientists were not the first people to look into a bear den. Indians noted the locations of dens they found in the fall and returned to them in winter to kill the bears for food. They respected bears and had special ceremonies surrounding the killing and eating of them. Members of the Winnebago Bear Clan called the first moon of January the bear moon because it is then that the cubs are born and then that the bears begin to lick their paws. Both observations are accurate. The Indians also believed that mothers washed their newborn cubs with fresh snow. According to a clan saying, snow during the bear moon meant that another cub had been born and that the bears, which had control of the weather, were calling for fresh snow to wash their young. Mothers do lick their newborn cubs, but the use of snow has not been documented in modern times.

Bears commonly lick their paws in late winter and early spring because their calloused foot pads and toe pads flake off during hibernation, and the newly exposed skin is not yet toughened up. Bits of the pads can be found in the feces in spring. Primitive people in northern latitudes around the world believed that bears licked or sucked their paws for sustenance in winter. The Winnebago version of this story is that bears walk on berries all summer, crushing the different

kinds into their paws so that in winter they can lick their paws and obtain the essence of the berries.

Another story, which has even been stated as fact in the scientific literature, is that bears eat roughage in the fall to scour the digestive tract and form a plug in the anus. The plug supposedly keeps the bear from eating anything more that fall. Actually, there is an anal plug of feces (along with some bear hairs and bits of nest material), but this forms mainly during, not before, hibernation. Bears continue to slowly make feces during hibernation, even though there is no food intake. Feces are composed not only of indigestible parts of food but also of cells that continually slough off the inside of the digestive tract. By spring, there is quite an accumulation of feces in the colon, and some bears defecate portions of this before emerging. In that case, the feces are deposited in or just outside the entrance to the den, rather than in the nest.

From early fall to late spring most black bears lose between 15 and 30 percent of their body weight. Lactating mothers can lose as much as 40 percent. The mothers that lose the most weight are the ones with the heaviest litters.

Most bears I observed left their dens in mid-April although mothers with undersized cubs sometimes delayed until early May. In years of light snow and early melt some bears left as early as March 27. In northeastern Minnesota, however, the bears rarely, if ever, came out and wandered around on mild winter days. Somehow the bears were not fooled by spring-like conditions before March 27. In one case, during March a fourteen-year-old female had a problem with meltwater running into her den and soaking the nest that she and her two month-old cubs were sleeping on. She left the den briefly and bit branches off several spruce saplings, bringing them back inside to pile onto the nest and raise the family above water.

For several years Wilson, Konz, and I observed the activities of four family groups day and night as they emerged from their dens in April. They were active only by day, and their activities were much the same in all cases. The mothers began foraging within 150 yards of their dens, leaving their four- to eight-pound cubs in the dens or playing around the entrances. The cubs retreated into the dens at any strange sound, and their mothers returned every ten minutes or less to check on them. The mothers tore apart logs in search of beetles, grubs, and other invertebrates high in protein, climbed aspen trees to eat catkins, ate willow buds and grass, drank meltwater, and in one case consumed a deer carcass we had placed near the den. (Winter-killed carcasses are usually not available to bears in spring because they are cleaned up by wolves, ravens, eagles, and other scavengers before the bears emerge.)

The mothers also spent a lot of time resting in or near their dens. When outside, the cubs were very active, climbing small trees, stumps, or their mothers' backs. Mothers nursed their cubs lying down or sitting up. One mother sometimes sat leaning back against a support, cradling two of her cubs to her chest and licking the tops of their heads as they nursed. After a few days, the mothers moved their families to patches of snow-free ground at the bases of large trees. The ground was still frozen and the surface was wet with meltwater. As all bears do in early spring, the mothers constructed beds to rest on. With trees available for the cubs to escape into, the mothers would leave their cubs for an hour or more.

With all the study of hibernating bears, a basic question remains: How do bears know when to go into or leave their dens? Certainly the bears live by some kind of internal clock, but what sets this clock – day length or some other cue – is unknown. Time of denning and emergence seems to vary to some extent with food supply, weather, and genetics, but how these and other possible factors interrelate is still a puzzle. For the Winnebago Indians the answer was simple: the black bear is a clever and intelligent animal.

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