spent the day in my research cabin north of Ovando in the Blackfoot River Valley poring through photographic equipment manuals to determine the lowest temperature of operation. Meanwhile, the radio was broadcasting severe winter weather warnings, with dangerously low overnight temperatures. Finally, I decided on a plan and headed into the forest.

A few hours later, after snowshoeing 6 or 7 miles into the backcountry, I stopped and began working in the diminishing February twilight. As quickly as possible in the freezing cold, I strung a rope of strobe lights along the branches of several trees. The lights were connected to a high-speed camera set on the ground and aimed at a gap in the tree canopy. The trees framed a tiny half-acre forest pond on the southern boundary of the Bob Marshall Wilderness. From previous field research by my graduate students and me, I knew that local female northern flying squirrels regularly travel along the shore of the pond. In winter, the squirrels emerge from roosting cavities shortly after midnight and range throughout the forest, traveling to their under-snow food caches by remarkably consistent routes. My goal was to photograph squirrels in flight in a natural context, something rarely documented.

Based on my previous observations, I expected one of the female squirrels I’d targeted to fly over the pond between 2:20 a.m. and 2:50 a.m. Unfortunately, the overnight temperature was predicted to plummet to -40 degrees F, greatly increasing the chance of camera failure. But the risks were worth it. In Montana, February is the middle of the northern flying squirrel’s mating season. Even in severe cold, each female is typically escorted through the forest by a squabbling squadron of ardent males. I was hoping also to photograph those males and their dizzying aerial mating chases.

LAUNCHING SKYWARD: To quickly gain elevation, flying squirrels push from the ground using powerful hind legs before opening their flying membrane and gliding to a nearby tree. Here a flying squirrel bursts from its cache of fir cones buried deep in the snow, leaving a potential intruder startled while gliding away to safety. “Walking through the forest at night, it’s like champagne bottle corks popping around you,” says the author. Such escapes are far less successful with raptors. Flying squirrels rustling noisily under snow become too confident in their explosive escape strategy and end up a staple winter food of great horned owls.
The northern flying squirrel is one of two flying squirrel species in North America. The other is the smaller but almost identical southern flying squirrel. The species in Montana ranges across Canada and Alaska through the northern Rockies and Great Lakes states, down to Appalachia’s cooler mountain zones as far south as North Carolina. The southern flying squirrel ranges across much of the eastern third of the United States from Florida north to the Great Lakes.

Flying squirrels feed on plant material, including seeds, nuts, and flowers, and also insects, bird eggs, and even meat scavenged from dead animals. Their passion for eating lichen, truffles, and other mushrooming species adds to their ecological importance. However, they are particularly preoccupied with finding food they become highly vulnerable to great horned owls and great gray owls, their primary predators. Great horned owls get so preoccupied with finding food they become highly vulnerable to great horned owls and great gray owls, their primary predators. They can be seen scavenge through the northern Rockies and Great Lakes states, down to Appalachia’s cooler mountain zones as far south as North Carolina.

Flying squirrels are well known for their amazing ability to glide among trees. The squirrel’s role as a central link in the grassy habitation’s ecological integrity is well documented. The flying squirrel is well known for its flattened tail, which adds an additional 25 percent of gliding surface. Just before landing, the squirrel drops its hips, opening up the patagia—the membranes on each side of its body—into a speed-slowing parachute and bringing the hind feet forward. A flying squirrel’s flattened tail adds an additional 25 percent of gliding surface. Just before landing, the squirrel drops its hips, opening up the patagia—the membranes on each side of its body—into a speed-slowing parachute and bringing the hind feet forward. It begins with a cloud of snow kicked up by two males chasing each other on the upper branches of a spruce tree high over my head. One lost his grip, then dove into a long glide over the pond, followed immediately by the second male in a rapidly accelerating glide. Both landed in the upper canopy across the pond—seemingly without much loss of elevation, despite a glide of at least 60 feet—and resumed their squabble. Then I spotted a female sitting quietly on a snow-covered branch against a tree trunk, inspecting a large fir cone probably left by a red squirrel during the day. A few seconds later, another male parachuted down from a nearby tree, somehow steering the end of his nearly vertical descent to land on the trunk right below the female. The female crouched, and in an exceptionally powerful jump with a fully extended body and outstretched hind- and forelimbs, launched herself at a 40-degree angle high into the air. She kept her patagia completely folded until reaching a height of about 10 feet. Then she spread the membranes wide open and, lighted by a series of high-speed strobe flashes triggered by my camera, seemed to freeze in midair for a moment before gracefully gliding out of view across the snow-covered pond. After engaging in a few barely audible squabbles from across the frozen expanse, occasionally kicking up more snow dust, the squirrel group disappeared into the dark and the night’s silence was restored. I was amazed. What I had witnessed was a spectacle, documented with my camera that and & documented with my camera that and...
180-degree turns to evade attacking owls; vertical leaps so high the squirrels could then soar from midair into a tree—often while carrying a pine cone weighing nearly as much as itself. It was obvious this species is capable of much more than just simple gliding.

I spent the rest of that night walking around to keep warm, watching an occasional owl for entertainment. At first light, I dismantled the by-then solidly frozen equipment with its long-dead batteries and started back to the cabin. I would spend many days afterward replaying and analyzing, frame-by-frame, the footage of these stunning performances to understand how they used the various anatomical adaptations that scientists had noticed in the lab but didn’t know what they were used for, he says.

**Summary**
The flying squirrel possesses an amazing evolutionary innovation—a “wing tip.” This cartilage at the aural opening, like a sixth digit though not attached to the others, is controlled by a powerful muscle. By adjusting the angle of the “wing tip,” the squirrel can generate a substantial lift, modifying the speed, distance, and trajectory of its glides midflight. This anatomical gliding innovation precedes the static endplates (“winglets”) that NASA began installing on the wings of modern jets in the mid-1970s by at least 20 million years.

A flying squirrel’s second novel physiological adaptation is the extensive musculature that crisscrosses its thin gliding membranes. These muscles, combined with limb movements during flight, allow a squirrel to actively modify the bowing of its “wings” and the orientation of fur on their surface. In a typical aereal chase, this produces wing shapes such as completely folded patagia; during powerful take-offs, fully extended membranes in the middle of long-distance glides; and fully inflated furry parachutes for slowing the squirrels’ nearly vertical descents.

Finally, unlike many other gliding mammals (which include some primates and marsupials), flying squirrels have an additional fur-covered membrane between their neck and wrists they can curve down to document in the wild how the flying squirrels use those remarkable features in flight. It turns out that flying squirrels are not just passive gliders. For instance, I saw them leap into the air from a tree trunk and then, as if forgetting something, turn 180 degrees in midair and return to the same trunk. And I witnessed that they can not only accelerate when gliding but also just as quickly decelerate just before landing so they don’t smash into the destination tree.

During flight. These “mini-patagia” guide air flow away from the larger patagia to lessen turbulence, while generating significant forward acceleration and lift. In short, flying squirrels combine, in a small furry package, features of heavy transport planes, agile military jets, and flexible-wing parachute gliders. Its anatomy makes the flying squirrel one of the world’s most sophisticated mammalian gliders.

Scientists have long known that flying squirrels were loaded with excess anatomical and physiological ingredients. But what purpose did they serve? Flying squirrels seemed overbuilt for simply gliding from one tree to another. My contribution from the nights spent in western Montana’s frigid woods was to document in the wild how the squirrels use those remarkable features to perform astonishing aerial maneuvers previously thought possible only in birds, bats, and other winged animals.

I have to wonder: What other marvelous features in these and Montana’s many other mammal species are still out there waiting to be discovered?

Over millions of years, flying squirrels have come up with elegant solutions to the same aerodynamic problems that face modern aircraft engineers. Maybe flight scientists and others can learn from these small, furry mammals. If nothing else, we now know why a flying squirrel can be equipped with these sophisticated features—to perform astonishing aerial maneuvers previouly thought possible only in birds, bats, and other winged animals.

I have to wonder: What other marvelous features in these and Montana’s many other mammal species are still out there waiting to be discovered? Want to see a flying squirrel in the wild? Badgley recommends watching your bird feeder after midnight if you live in forested areas of western Montana where the squirrels frequent. “The main way people know they have flying squirrels around is they see the tails left behind by great horned owls that feed on them,” he says.