'What are these bats telling us about the environment we live in?'

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Labs race to unravel deadly illness that may have broader impact

By Beth Daley, Globe Staff | May 4, 2008

DORSET, Vt. - The little brown bat careened out of Aeolus Cave into the bright March afternoon. Crashing into a snow bank, it clawed up the icy mound, wings flailing wildly. Spent and starving, it fell still.

Dozens of furry bats, many shivering uncontrollably, littered the snow around the cave's mossy entrance. Others in various stages of dying were tucked into rock crevices nearby - deeply bizarre behavior for animals that avoid light and so despise winter they can hibernate until early May.

A wildlife biologist breathing through a respirator gingerly picked up the still creature - one more critical clue to a mysterious illness that is killing the bats of the Northeast.

For more than four months, perplexed scientists have struggled to understand why upwards of a half-million bats may be at risk of dying in the dark caves and mines of Massachusetts, Vermont, Connecticut, and New York. Last year, thousands of dead bats were found in four caves within 7 miles of one another. This year, at least 25 caves and mines spread across 135 miles were found to have sick or dying bats. Homeowners from Hanover, N.H., to East Canaan in northwest Connecticut have reported dead bats on lawns, decks, and roofs, a sign the animals might be affected in an even wider area. But so far, no one has found an infectious agent or any other cause.

It is a race against time.

Bats are now migrating as far as 250 miles to their summer roosts, where they will mix with bats from other far-off caves and mines. By fall, they will travel back to their hibernation site to mingle and mate with still other bats. If the sickness is contagious, millions more of the animals around the country could be at risk next year.

Finding an answer is critical for a population that eats thousands of tons of crop-infesting and human-biting insects. But scientists also worry that the sick bats are a potent sign of changing conditions in the natural world.

"What are these bats telling us about the environment we live in?" asked Beth Buckles, assistant professor of biomedical sciences at Cornell University's College of Veterinary Medicine and one of the researchers leading the hunt for the causes of the problem. While humans do not appear susceptible to the illness, scientists worry that a large bat die-off could disrupt nature's balance in unpredictable ways. "We are in the middle of something historic here," she said.

Some are comparing the bat sickness to the massive population decline among honeybees in North America, which also involves animals that cluster together. Scientists have not found any link, other than the realization that neither event appears to have an identifiable cause.

Now, dozens of pathologists, immunologists, toxicologists, wildlife biologists, and other researchers in more than 15 government, university, and private labs are methodically working to unravel the bat mystery. Government grants are being written to fund more in-depth work. Scientists are using cutting-edge technology, from heat-detecting cameras in muddy bat caves to DNA analysis in sterile labs. Even a Columbia University molecular epidemiologist who discovered a possible contributor to the bee colony collapse has joined the sleuthing.

"We've got to find an answer," said Susi von Oettingen, an endangered species biologist with the US Fish and Wildlife Service. "And in so many ways, we really don't know where to start."

An illness spreads

Joe Armstrong's heart sank. The 43-year-old caver was in Haunted Castle, a remote spur in upstate New York's Howe's Cave in January. Just as he was about to leave, his headlamp trained on a single bat with what looked like frost on its nose.

Weeks earlier, Armstrong, the conservation chairman for the Northeastern Cave Conservancy, had heard about a strange and what authorities hoped was an isolated 2007 bat die-off that involved animals with white faces at four nearby caves west of Albany.

Armstrong immediately called New York state bat biologist Al Hicks at home. The next morning, a Sunday, Hicks was in Haunted Castle. He and another scientist peered at the bat. The white frost was the same fuzzy white fungus he had seen on bats the year before.

"We knew then the genie was out of the bottle," Hicks recalled recently. "It seemed to be spreading."

Wildlife biologists, dressed in protective white suits and wearing respirators to keep from spreading the sickness unwittingly, began exploring icy, dark mines and caves across the Northeast, sometimes aided by experienced cavers who knew the damp, maze-like passages. They traded their findings on a bat conservation discussion group on the Internet.

Six species of bats appeared to be affected, though little brown bats seemed hardest hit. Not all the dead bats had white noses, but enough did for scientists to dub the sickness "white nose syndrome." Most had virtually no fat on their body, indicating they had starved. But even some live bats that were a healthy weight and lacked white fungus were acting strangely by flying out in the middle of the day. Mortality in some caves was nearing 100 percent.

No one had seen anything like it.

"We hope that our concern is overblown and that in a short time people are laughing at us for saying, 'The sky is falling, the sky is falling,' " Virgil Brack Jr., a bat consultant and assistant director of the Center for North American Bat Research and Conservation at Indiana State University, wrote in an e-mail to the group in January. "But until that proves to be the case, this . . . scares the hell out of us."

An elusive killer

At first, researchers hoped it would be easy to pinpoint the bats' killer.

In a lab filled with stainless steel at Cornell's College of Veterinary Medicine, Buckles and her students began receiving dozens of bat corpses.

They painstakingly examined each animal before placing its lungs, heart, and other organs in preserving fluid. Then, they examined tiny slices of the organs, stained bright pink or blue, under a microscope. If the cells looked abnormal - fragmented or oddly shaped, for example - it could mean that the animals were fighting a virus, bacterium, fungus, parasite, or toxin. But they saw no pattern indicating an immune response in the bats, even the ones with white nose fungus.

Other Cornell scientists searched for toxins or pathogens hidden in the tissue. Still no pattern. That meant, as far as they could tell, that an infection did not seem to be killing the bats.

Meanwhile, the count of sick bats was rising. White nose was confirmed in Vermont's Aeolus Cave on Valentine's Day. Bats in more than a dozen New York caves had the illness by the end of February. Sick bats were found in Connecticut in March. Reports of white nose, still unconfirmed, are now trickling in from Pennsylvania.

In Chester, Mass., biologists didn't have a chance to investigate the honeycomb of old emery mines before residents began calling: Dead bats had to be kicked off porches. Carcasses were sticking to houses.

"We used to go outside in the spring, have a beer, and watch the bats come out at dusk from the mines," said Mary Ann Pease, the town tax collector as she walked her dog through the speck of a downtown. "But we know that isn't going to happen anymore."

Unable to identify an obvious infectious agent - the white fungus appears to strike bats already weakened by

something else - scientists around the country began looking down other paths. Could pesticides have killed so many moths, beetles, or midges that bats didn't have enough to eat the previous fall? Were they going into hibernation without enough fat to make it through the winter? Did the fungus make the bats so itchy that they woke up and expended precious energy scratching?

Some members of the public suggested the reason was electromagnetic radiation from cellphone towers. Three people e-mailed The Boston Globe convinced the bats were dying from government planes they suspected were spraying mysterious chemicals each morning.

Whatever the cause, scientists realized they were stalled by a fundamental problem: They really didn't know enough about healthy hibernating bats.

Gaining an understanding

Tom Kunz of Boston University is, truly, batman. It's not because of the pile of stuffed bats on a filing cabinet in his paper-strewn office. It's that he has been studying the mystical creatures for more than 40 years.

Despite all that experience, he still doesn't understand exactly how a hibernating bat's immune system works. He does not exactly know how much body fat a bat needs to make it through the winter healthy enough to reproduce.

The answers are critical. It's hard to determine what's gone wrong with sick bats without being able to compare them with healthy ones.

"We need to know so much more about their ecology and physiology" to figure this out, Kunz said.

The lack of basic knowledge slowed the investigation. Ian Lipkin, the Columbia University epidemiologist, agreed to use a sophisticated molecular method he had developed to look for pathogens by comparing healthy bats with unhealthy bats. Lipkin's lab used this method to discover a virus in bees in hives affected by colony collapse disorder, a potential key contributor to that species' decline.

But he needed to be certain healthy bats were truly healthy. A sick bat could look healthy if the illness had not had time to cause symptoms yet.

Supposedly healthy Pennsylvania bats were sent to Lipkin, but Buckles was uncomfortable. They were collected only 200 miles from an affected New York mine, and there was growing concern Pennsylvania had sick bats. The group decided to collect bats farther away, from Wisconsin, and Lipkin is now running his tests.

Increasingly, scientists believe a confluence of factors is contributing to the bats' demise, sort of a one-two, and possibly three, punch.

One hypothesis proposed by Kunz and his graduate students is that hibernating bats may need to arouse to jump-start their immune system to fight off a pathogen or contaminant. If bats enter hibernation without enough body fat, for whatever reason, they may be unable to muster enough energy to arouse and get their immune system going, the BU group figured.

On Feb. 13, Marianne Moore and Jon Reichard, two of Kunz's graduate students, rappelled 120 feet into Williams Hotel Mine, an old limestone cement mine in upstate New York, to test the hypothesis.

Quietly, they grabbed hibernating, cold bats off the wall and drew blood. Then they tried to wake up some bats to obtain blood during different stages of arousal. Some awoke, others didn't, an odd sign. They poked the bats to arouse them. Still no response.

Reichard set up a heat-detecting video camera to record the animals' body heat, in case they were arousing a bit but just not enough for the researchers to notice. Even after three hours, some bats never woke up.

Once they extracted themselves from the icy mine, Moore and Reichard took the frozen blood samples back to the BU lab.

There, Moore mixed bat blood, taken during different states of arousal, with bacteria in small vials. Later, in petri dishes, she counted how many bacteria were killed, as a measure of immune system activity. While her

data are still preliminary and only suggestive, Moore said it appears that there was less immune activity in the blood taken from less-aroused bats. If confirmed, that means their hypothesis could be correct. Something no one has detected yet could be invading the bats' bodies, and their immune system just can't fight it when they are in deep hibernation.

"We still need a lot more information," Moore cautioned. Researchers plan to gather in Albany next month to decide which potential causes to the bat illness appear the most promising to pursue in the coming months, as bats again prepare for the next hibernating season.

A hopeful expedition

Two weeks ago, a team of New York researchers hiked a half-mile up a mountain path strewn with felled trees and branches to place a bat trap across a hard-to-find entrance to an Adirondack mine.

Inside the mine, near rusted machine parts once used to extract iron ore, the squeaks and chirps of thousands of bats could be heard. Bats writhed and squirmed in clusters of hundreds per square foot as they prepared to leave the cave and begin the long flight to their summer roosts.

There is hope here. When Hicks, the New York state bat biologist, visited the mine in March, he saw little evidence of white nose. And he expected to see a lot: Other mines in the area have sick bats.

Perhaps, he and other scientists wondered, this mine's dry conditions somehow helped the bats withstand the illness. Humidity levels in the cave average about 65 percent, compared with close to 100 percent in most caves and mines.

Hicks and three fellow bat catchers got ready as the sun set. A trickle of bats began flying out of the 15-foot wide entrance. The bat trap, monofilament strung across two metal bars, worked. Some bats were unable to navigate around the trap and flew into the wire. Stunned, they dropped to the ground.

The researchers, wearing white gloves and miner lamps, grabbed each bat to weigh, measure, and examine the animal for white nose, before letting it go.

Hicks needed to catch hundreds of bats to see any trends. By 11:30 p.m., after almost nine hours on the mountain, they had caught only 65.

But the bats they did catch were a healthy weight. And fewer than a half-dozen had the white fungus. Was it a good sign?

"We need more bats to know," said the exhausted Hicks as he and the crew packed up their gear before gingerly stepping over logs and spruce branches on the way down the mountain.

Near their car, the crew paused. Someone shouted and pointed. It was a bat, starting the journey to its summer roost, silhouetted against the moon.

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