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What's killing the bats?

At least 1 million have died in the past three years from a mysterious disease, posing serious questions for our environment. But one Boston University biologist is leading the hunt for answers.

By Stacey Chase | November 15, 2009

Thomas Kunz emerges from Aeolus cave in East Dorset, Vermont, with a half-dozen metal ID bands -- smaller than SpaghettiOs -- cupped in the palm of his latex-gloved hand. They're tiny emblems of death, having once been affixed to the forearms of little brown bats.

The renowned bat biologist from Boston University, who bears a passing resemblance to Harrison Ford, minutes earlier had recovered the bands while trudging, like a real-life Indiana Jones, through a slippery mud-like ooze of rotting bat carcasses, liquefied internal organs, toothpick-sized bones, piles of guano, and a strange white fungus on the cave floor.

If bats had come out of hell, it couldn't have been worse than this.

"What we saw was bat soup. There were a lot of bones of wings and skulls and emulsified bodies," Kunz says. "There were dead bats -- decomposing bats -- hanging from the walls of the cave.

"My heart sunk," he says, noting some of the bands bore his initials, THK. "It was as if I had lost family members."

It's late August, when bats are in their swarming phase, and the 71-year-old Kunz and two fellow biologists have trekked, at night, in hard rain, with heavy gear, 2,520 feet up the rugged Taconic Mountains to Aeolus -- the largest bat hibernaculum in the Northeast -- to bleed live bats and collect samples for researchers leading the hunt for clues into the cause of mysterious bat deaths like these.

At least 1 million bats in the past three years have been wiped out by a puzzling, widespread disease dubbed "white-nose syndrome" in what preeminent US scientists are calling the most precipitous decline of North American wildlife in human history. If it isn't slowed or stopped, they believe bats will continue disappearing from the landscape in huge numbers and that entire species could become extinct within a decade. It's enough to make some wonder: Is the bat in the cave the new canary in the coal mine?

"We're at the vanguard of an environmental catastrophe," says Tim King, a conservation geneticist with the US Geological Survey in West Virginia. "There's very little definitive information available at this point. Everybody's just scrambling, with very limited resources, to do whatever they can to help -- help stop this."

The little brown bat, historically among the most common of North American bats, has been the hardest hit of the six species known to be afflicted with the baffling illness. The others are: the big brown bat, the Eastern small-footed bat, the Northern long-eared bat, the tri-colored bat (formerly known as the Eastern pipistrelle), and the Indiana bat.

The mass deaths are difficult to quantify because wild bats are almost impossible to count, but to scientists monitoring hibernation sites, serious declines are as undeniable as they are unprecedented. Population counts at two dozen small winter colonies in Massachusetts, New York, and Vermont show they have plummeted from 48,626 bats to 2,695 -- an average 94.5 percent decline -- since the outbreak began.

"If it continues at this pace," says New York bat specialist Alan Hicks, "in a few years we won't have any [of these] bats."

Scientists are alarmed that white-nose syndrome, unlike many wildlife diseases, is a multi-species killer, infecting nearly every cave-dwelling bat species in states where it has struck. It attacks the bats as they hibernate in caves and mines, typically from mid-October to mid-April.

Since white-nose was detected in February 2006 by a caver photographing a private section of Howe Caverns near

Albany, New York -- considered the disease epicenter -- its spread, from New England to South Atlantic states, has been terrifyingly swift. Infected hibernation sites were discovered the second winter less than 20 miles from Howe; the next, about 120 miles; and by last winter, more than 650 miles.

In addition to Massachusetts, New York, and Vermont, the plague-like condition has been confirmed in Connecticut, New Hampshire, New Jersey, Pennsylvania, and, earlier this year, Virginia and West Virginia. It appears headed toward caves and mines in Kentucky and Tennessee, and possibly North Carolina and Ohio. (There have been no confirmed cases in Ontario or Quebec.) For Kunz and his colleagues, this winter will be telling.

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White-nose syndrome gets its name from the white fungus that looks like confectioners' sugar found around the noses -- as well as on the ears, wings, and other exposed skin -- of many infected bats, though not all show signs of the disease.

Researchers strongly suspect but have not proved that the sickness is caused by a newly identified cold-thriving soil fungus aptly named Geomyces destructans. (Some believe the fungus is a secondary infection that grows on bats with already weakened immune systems.) Nor have they unraveled the enigma of a perplexing chain of events that leads from an apparent fungal infection to erratic bat behavior to death by what appears to be starvation.

The hallmark of the syndrome is a skin infection that creates holes in and scarring of the bats' wing membranes, causing them to lose elasticity. "It's challenging to think of why an animal might die of a skin infection. Isn't that just like getting athlete's foot?" says David Blehert, director of diagnostic microbiology at the National Wildlife Health Center in Wisconsin and lead author of the report that identified the fungus. But you can't really liken it to that, he explains, because this infection "actively invades living skin cells."

Initial white-nose studies have produced two consistent findings: The fungus has been found on bats at every site where mass deaths have occurred, and most of the dead bats are emaciated. But the link between them has evaded scientists. The leading hypothesis -- Kunz shorthands it as "itch and scratch" -- is that the fungus irritates the bats' skin, arousing them more frequently than normal in hibernation to groom it off. Those actions, the thinking goes, squander their fat reserves until, ultimately, they starve to death.

The animals, which are nocturnal, are exhibiting other aberrant behaviors, such as clustering near cave entrances where it's coldest, perhaps an attempt to lower body temperatures further to conserve energy, and flying around outside in winter, in daylight, possibly in a desperate search for food.

Because Geomyces destructans grows in chilly cave-like temperatures, optimally 41 to 57 degrees Fahrenheit, bat biologists originally thought the die-offs might end when surviving bats fled the hibernacula. But they kept on dying into May and June. "Even those bats that might make it through the winter may have sufficient wing damage that they've lost maneuverability and they can't catch food very effectively," says DeeAnn Reeder, a bat researcher at Bucknell University. "So, there's all of these things that are happening to them, and we haven't connected those dots."

Heightening concerns further, female bats give birth just once a year to a single pup or twins. "They are not going to be able to rebound from this very quickly, if at all," says Vermont Fish and Wildlife biologist Scott Darling.

Scientists are not certain how white-nose syndrome is spread but say its rapid dispersal suggests bats -- which can migrate 200 miles between summer roosts, where they intermingle, and hibernation sites -- are most likely transmitting the disease to one another. Increasingly, however, there are suspicions that humans who explore caves and mines may play a role in the spread by unwittingly carrying fungal spores, which attach to their clothing and equipment, from infected sites to clean ones. As a precaution, the US Forest Service last spring closed approximately 2,000 caves and mines in 33 states in its Eastern and Southern regions for up to one year. The action followed a US Fish and Wildlife Service request that the public observe a caving moratorium in 17 states. Since then, cave owners and managers have closed dozens more.

Of the six species of bats affected so far, only one -- the Indiana bat -- is on the federal endangered list. If white-nose syndrome continues its anticipated blitzkrieg deeper South and into the Midwest, three more species on that list are likely to be imperiled: the gray bat, the Virginia big-eared bat, and the Ozark big-eared bat. Yet even fears that some species could vanish entirely are being overshadowed by the enormity of ordinary bats, like little browns, dying by the tens of thousands. No one can predict the ecological fallout from

1 million dead bats -- some say the actual figure might be double that -- but whenever something is taken out of the

ecosystem in large numbers, there are obvious concerns.

“Given that the little brown was so numerous and now has become so rare, the potential for impacts on the insect populations and the rest of the ecosystem is much greater [from its decline] than from the decline of species that were already fairly uncommon,” says Mollie Matteson, a conservation advocate with Vermont’s Center for Biological Diversity.

All the bat species under siege by white-nose syndrome voraciously feast on night-flying insects like moths, beetles, and leafhoppers that damage agricultural crops and defoliate trees. Fewer bats mean fewer insects consumed, which, in turn, could increase the need for pesticides -- which could set off other unforeseen environmental consequences. Bats also devour mosquitoes, and more mosquitoes mean greater exposure to the diseases they transmit, like West Nile virus and Eastern equine encephalitis. (There is no evidence the bat fungus poses risks to human health.)

The insect-eating ability of bats is staggering: Little browns and other species can consume up to half their body weight in insects a night. Kunz estimates that there are 694 tons of insects loose in the environment now that would have been consumed by the estimated 1 million bats that have already died.

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Back At Aeolus Cave, a captured little brown -- turned on her back and chirping -- is clinging to biologist Ryan Smith’s gloved thumb as Kunz pricks a tail-membrane vein with a micro-injection needle, then extracts the blood in glass capillary tubes. Nearby, a third biologist, Susi von Oettingen, gingerly unfolds a just-euthanized little brown’s rice-paper-thin wing on a white cutting board and, using a biopsy punch, removes a dark speck of skin the size of a pepper seed.

As a pall of death hangs in the cool night air, the bat biologists do the tedious, unglamorous work of collecting blood, tissue, feces, and other samples that they and other researchers across the country need to solve this fatal riddle. Six months earlier, biologists monitoring Aeolus were horrified to find the floor carpeted with about 20,000 freshly dead bats.

Though bats loom large in our imaginations and mythology, up close the “Lucys” -- the nickname of little browns, or Myotis lucifugus -- are astonishingly fragile creatures with shiny black, map-pin eyes and black, five-digit feet that eerily resemble human hands but are the size of pencil erasers. They typically weigh less than three pennies.

“We just haven’t studied them enough,” says von Oettingen, who works at the US Fish and Wildlife’s field office in New Hampshire. “They’re not charismatic. . . . We don’t make money off of them. They are not cute and cuddly.”

The struggle to save the bats has been exasperating because scientists knew frustratingly little about bat ecology to begin with. Now, though, the deadly disease is focusing attention on bats -- the world’s only flying mammal -- like never before. Scientists across the country have convened in Austin, Pittsburgh, and other cities in the past year to discuss everything from possible fungicides to bat genetics, and on June 4, US House subcommittees held hearings on the unexplained deaths.

Still, the response to the deepening crisis has been crippled by a lack of funding and coordination -- one critic calls it a “many-tentacled octopus” -- among the more than 52 federal and state agencies, academic institutions, caving and conservation groups, and others working on the problem.

Officials at the US Fish and Wildlife Service, the lead agency on white-nose syndrome, say about $3.3 million has been allocated to date to study the disease’s causes and effects on bats. Two weeks ago, an appropriations bill that earmarks $1.9 million for research this fiscal year became law. However, in a budget request he prepared for Congress, Kunz estimates scientists and wildlife managers need $17.6 million this fiscal year, and $38.3 million more over the next four, for critical research, surveillance, and management.

A biology professor and director of the Center for Ecology and Conservation Biology at Boston University, Kunz has been studying bats for more than 45 years and is uniquely qualified for his leading role in efforts to solve the white-nose syndrome mystery.

Currently, he and researchers in his “bat lab” are conducting studies, among others, focused on how wing damage caused by the disease (and possibly frostbite) affects the little brown bats’ ability to navigate and whether the bats can effectively mount an immune response to Geomyces destructans. Kunz has a brevity atypical of scientists when describing his lifelong passion for bats. “They’re nocturnal. They’re secretive,” he says. “I just found them fascinating creatures to study.”

Before white-nose syndrome, Kunz was perhaps best known for pioneering applications of thermal infrared imaging of bats to assess their impact on agriculture and forest ecosystems. Earlier in his career, he did extensive field work on tropical, fruit-eating bats in India, Ecuador, and other foreign countries, and, in Malaysia, discovered a species of wild bat in which the male lactates.

Last month, Kunz's lifetime of work was recognized with his nomination for the $100,000 Indianapolis Prize, the world's top animal conservation award. Has he considered retirement? "No. I'll probably continue my research on bats until I keel over," he says, chuckling. "I'm having too much fun."

The latest research examines a strange new twist. European scientists have begun tracking a fungus similar in appearance to Geomyces destructans that has affected bats (different species than their American cousins) for at least two decades -- but with no attributable deaths. The unnamed fungus had been observed in seven countries, including Germany and Switzerland, as far back as the 1980s but piqued interest after America's devastating bat losses; genetic tests are underway to determine if the fungi are the same. A match could intensify speculation that European cavers inadvertently carried the fungus to New York bat caves on their gear.

"It would really be helpful to know if they have the same fungus on bats, and, if so, why it's not killing them," says Paul Cryan, a research biologist with the US Geological Survey in Colorado.

Some have tried to draw connections between white-nose syndrome and other, equally mystifying wildlife diseases such as the chytrid fungus that has killed off dozens of frog species over the past three decades and the colony collapse disorder that has decimated about a third of US honeybee colonies in the past few years. Scientists have found no links. Still, Scott Darling, the Vermont Fish and Wildlife biologist, wonders if all the phenomena, taken together, serve as some kind of ominous warning.

"This is more than just about bats dying. It's about a key player in our ecosystem disappearing before our eyes," Darling says. "It may be a model for the severity of diseases that our native species are going to be confronted with.

"If it's frogs yesterday, bees two days ago, bats today, and something else in two more years," he adds, "how long before this system falls apart on us?"

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