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Return of the (Bat) Mummy

A desert cave preserves a 10,000-year-old spotted bat

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A very long time ago, a spotted bat poked his head into a crack in the limestone wall of northern Arizona's deepest known cave. The male bat, apparently looking for a day roost, found himself hopelessly stuck. He died there, trying to extricate his head. The crack became his eternal roost, and there he stayed for more than 10,000 years. The cave's still, dry air mummified the small body.

In 1994, two cavers came upon the bat's dried remains, still stuck in the crack. The mummy itself was easily identified by its unique coloration. Spotted bats (*Euderma maculatum*) are among the most easily recognized bats, with their large pink ears and striking black-and-white fur.

But modern spotted bats are not known to roost in caves, choosing instead cracks and crevices in vertical rock faces. Only two documented sightings of spotted bats in caves had been reported before 1994: a single bat day-roosting at the entrance to a small California cave in 1948, and four bats hibernating in a Utah cave in 1930.

The remarkable discovery of the Arizona mummy is – directly and indirectly – changing that and other assumptions about spotted-bat behavior. And more surprises are likely. The cavers who found the bat mummy remained at the site for several days. Each night they heard echolocation calls emerging from the depths of the cave – calls that, unlike those of most bats, were audible to the human ear. This is one of few North American bat species with such low-frequency echolocation calls. Could spotted bats be living in the cave even today?

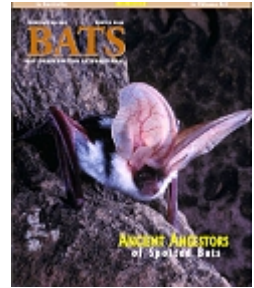
Scientists from the Arizona Game and Fish Department, Northern Arizona University and the Navajo Nation Department of Fish and Wildlife accompanied the two cavers back into the cave to search for any other mummified bats and to determine the age of at least one of them. We also hoped to confirm whether spotted bats were day-roosting in the cave.

The mummified remains of seven spotted bats were found in the cave, along with a few individuals of other local species. All were on the cave floor and in various stages of decomposition.

Along the way, we confirmed the surprising early hints that spotted bats do indeed use caves. We set mist nets at the cave several times from 1995 to 1997 and documented the presence of six to nine spotted bats. They were roosting in the fissured and fragmented limestone ceiling, 100 feet (30 meters) above the cave floor. From May to October, these bats came out of the cave just after sundown, emerging individually or in pairs, up to 10 minutes apart. They returned just before dawn.

Our original mummified bat was radiocarbon-dated, thanks to geology Professor Jim Mead of Northern Arizona University, to approximately 10,400 calendar years ago.

(Radiocarbon dating is calculated from the decay of radioactive carbon isotopes that are present in all living things. This very well-established dating technique determines the time of a plant or animal's death in what are called radiocarbon years, which differ from the



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regular calendar years we are used to. A radiocarbon date can, however, be converted to approximate calendar years. Our 10,400-year-old bat mummy had produced an age of 9,180 radiocarbon years, ± 50 years.)

The doomed spotted bat went searching for a roost at a time when Earth was undergoing dramatic shifts in climate. Vast glaciers were receding and sea levels rose more than 100 feet (30 meters). Many large mammals – mammoths, mastodons, saber-toothed cats and giant sloths – were disappearing. And the American Southwest was becoming habitable for the first time in many millennia. This likely was the first time the spotted bat, and many other animals, could survive here.

Our research resumed in 2003, after a hiatus of several years, with a grant from Northern Arizona University, and the research team expanded with the addition of U.S. Bureau of Land Management and U.S. Forest Service biologists. We planned to calculate the age of the other six mummified bats in hopes of determining whether all died together, perhaps in a catastrophic event of some kind, or whether the remaining bats might help to show continuous occupation of the cave for thousands of years.

At the same time, we hoped to learn more about foraging habits of the cave's current occupants by attaching tiny radio transmitters to several spotted bats and tracking their movements. We had theorized that these bats' behavior might be similar to that of spotted bats studied in the Grand Canyon by Melissa Siders (formerly with the U.S. Forest Service), Mikele Painter (U.S. Forest Service), Elaine Leslie (formerly with Grand Canyon National Park) and Mike Rabe and Tim Snow (Arizona Game and Fish Department). Bats in maternity roosts of the Grand Canyon and Kanab Creek area travel nearly 35 miles (56 kilometers) nightly from the depths of the Grand Canyon at an elevation of approximately 2,400 feet (730 meters), over the Grand Canyon rim (at 6,100 feet [1,859 meters]) and out to the North Kaibab Plateau (at 8,200 feet [2,499 meters]) to feed on moths at the high-elevation meadows.

We collected the six remaining -spotted-bat mummies from the cave under sterile conditions to avoid contaminating the samples. Small patches of skin were removed from each bat and sent for radiocarbon dating. None of these bats was nearly as old as the original mummy. The two oldest were dated around 2,100 and 1,450 years old, while the remaining four samples were less than 300 years old.

The range of ages among all seven mummies strongly suggests a remarkable conclusion: This cave probably has been used by spotted bats, more or less continuously, for 10,000 years.

Moving from the distant past to the present, we netted four male spotted bats as they emerged from the cave in June 2003. Each of the bats was quickly tagged with a tiny transmitter weighing 0.67 gram (just over one-fourth the weight of a penny) and sent on its way. The transmitters' batteries last about 14 days, so we, along with several very dedicated volunteers, tracked the four bats from dusk to dawn every night for two weeks.

Our results are still being analyzed, but one intriguing discovery already has emerged from the data: Spotted bats from the cave routinely used alternate roosts in the vertical cliffs along the Colorado River in Marble Canyon. This is a typical roosting habitat, long known to bat biologists, that is rich in cracks and crevices that provide protection from predators and the day's heat.

We also quickly discovered that the bats were not flying to the top of North Kai-bab

Plateau as we expected. They were foraging most-ly over the desert scrub of the valley floor and the canyon tributaries of Marble Canyon. They flew to slightly higher elevations only to night roost in nearby piñon/juniper woodlands.

Yet these spotted bats were covering a similar distance – about 50 miles (80 kilometers) – as the Grand Canyon females that forage on the North Kaibab. Remember: This is a 15- to 22-gram (0.5- to 0.75-ounce) bat with a wingspan about the same as an American robin's. Traveling 50 miles each night, at times reaching 30 miles per hour (48 kph), in search of food and water is quite a feat!

We hope to conduct studies with hair and tissue samples collected from the four contemporary bats. Radioisotope analysis will reveal aspects of their diet, and genetic analysis may determine whether our modern-day spotted bats are related to their mummified predecessors in the cave.

These ancient bats opened a treasure chest of information and there almost certainly are more surprises yet to come.

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