De-Extinction in Action: Scientists Consider a Plan to Reinject Long-Gone DNA into the Black-Footed Ferret Population

The DNA, found in museum and frozen specimens, would boost the species's diversity

- By David Biello on August 1, 2016

Three hundred black-footed ferrets live in zoos and a captive-breeding program. A few hundred more live in the wild. *Credit: BOB ROZINSKI Getty Images*

In 1987 only 18 black-footed ferrets were known to exist, but thanks to captive breeding and intensive management, the animals are a few hundred strong now. Yet like many species that bounce back from such small numbers, all the individuals are basically half-siblings—genetic near clones, with the same susceptibility to hereditary health problems, to potential pathogens or to environmental changes that could lead to population collapse. In an effort to boost the ferrets' genetic variability and odds of long-term survival, the Fish and Wildlife Service (FWS) is considering something extreme: a plan to reintroduce DNA that was lost to the population but still exists in long-dead specimens stored in zoos and museums. The effort may not sound as outlandish as the dream of resurrecting the woolly mammoth, but it does involve reviving genes that died with their hosts—and as such, it won't be easy.

The black-footed ferret's bottleneck was even worse than it sounds. Of the 18 individuals the FWS rescued nearly 30 years ago from the U.S.'s prairies, only seven passed their genes to subsequent generations. “Every black-footed ferret comes from seven individuals,” says Kimberly Fraser, a spokesperson for the FWS's National Black-Footed Ferret Conservation Center. “Take seven humans, and what would we have?”

Last year geneticists funded by the Long Now Foundation's Revive & Restore effort sequenced the genomes of two living ferrets, as well as the DNA of a male and female who died in the 1980s and are stored at the San Diego Zoo's Frozen Zoo. A comparison of the pairs suggests that genetic diversity exists in storage and could be brought back into the living population through, for example, cloning or CRISPR gene editing. This has been explored in attempts to resurrect species such as the passenger pigeon and could theoretically be used to create clones of the frozen ferrets, which could then be bred with living ferrets. The clones' genomes could also be tweaked to incorporate DNA sequences that code for antibodies to fight two common infections: bubonic plague and canine distemper. Or the genes that make ferrets susceptible to these diseases could be removed. “To have two more genetic founders? That would be a lot,” says Ryan Phelan, executive director of Revive & Restore.

The ferret has some advantages in this fight: it is a fast breeder and has close relatives that are thriving and could be used as a surrogate for preliminary cloning research. But it is no surprise that this type of genetic tinkering faces challenges, such as finding adequate funding and facing the legal sticking points that surround genetic projects involving endangered species. Then there are the scientific hurdles, which include the notoriously difficult challenge of creating a viable clone and the long decision-making process about what genes to add or delete. The Revive & Restore group plans to begin the initial gene-editing work this year in cultured cells under the auspices of the Zoological Society of San Diego, assuming funding and researchers can be found.

If genetic rescue can help the black-footed ferret thrive, perhaps it can work for other animals and plants that conservationists are trying to save—including amphibians nearly wiped out by chytrid fungus and the inbred Tasmanian devil, which is being ravaged by a contagious facial cancer. In fact, a similar genetic restoration effort is already under way to save the northern white rhino, a subspecies with only three individuals remaining. That attempt will employ the frozen sperm of dead male rhinos as well as “artificial gametes”—stem cells engineered into sex cells that contain restored gene variants. The international team of scientists carrying out the effort recently detailed its plan online in *Zoo Biology*, writing that “[the northern white rhino] can be considered doomed for extinction, unless extraordinary efforts are made to prevent this outcome.”

In all such cases, there are ethical considerations. For example, a key argument against de-extinction is that money should not be wasted on resurrecting the mammoth when there are real elephants to save, and those limited funds could be better spent on protecting habitat or supporting antipoaching infrastructure. The ferret project, however, would show that the techniques of de-extinction can be applied to real conservation with existing species that are on the brink. As Phelan puts it: “This is a question of at what point do we as stewards help out populations that don't have all the evolutionary adaptability they might have had if things had been different?”

The FWS's ultimate goal is a wild population of 3,000 breeding ferrets spread across 30 different populations, and the service plans to finally restore ferrets to the last place in the wild they were ever found: Meeteetse, Wyo. But without this genetic restoration effort, inbreeding could push the animals back into decline or even extinction. “I don't know that you can spend 100 years in a captive-breeding program and have the limits on genes that we do,” FWS's Fraser says. “I hope [genetic rescue] happens before I die.”

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