De-Extinction

"If it's clear that we exterminated a species, I think we have a moral imperative to do something about it." — M. Archer

Imagine a world where mammoths still walk and passenger pigeons still fly. It may happen sooner than you think. Rapid advances in biotechnology and genetic engineering are causing scientists to seriously discuss the possibility of *de-extinction*, bringing an extinct species back to life.

One method with great promise is somatic cell nuclear transfer (SCNT), used to create Dolly, a cloned sheep in 1996. SCNT uses the nucleus from an adult cell, a mammary cell in Dolly's case, which is transferred to an unfertilized egg that has had its own nucleus removed. Next the egg is electrically shocked to stimulate it to divide and then implanted in a surrogate mother. The resulting animal is a clone, genetic twin, of the cell nucleus donor. Many animals have been cloned this way, but the success rate is low. Currently only 1% - 5% of cloned embryos make it to full-term, and many of those develop abnormally.

Since viable nuclei are required for SCNT, it cannot work for long-gone species. But in 2003 a team of Spanish scientists used nuclei from frozen tissue of the last known Pyrenean ibex (*Capra pyrenaica pyrenaica*), a sub-species that died out 13 years earlier, to successfully clone the extinct animal. The newborn died from a lung abnormality within minutes. Nevertheless, SCNT is still a promising way to achieve de-extinction.

For example, Michael Archer, a paleontologist at the University of New South Wales, Sydney, Australia, is attempting to revive two frog species that recently went extinct. So far he has been able to get developing embryos (blastocysts) from the implanted eggs, but they die in few days.

The wooly mammoth (*Mammuthus primigenius*) went extinct ~4,000 years ago. Using perfectly preserved frozen carcasses exposed in melting permafrost, scientists hope to one day clone a mammoth using an elephant surrogate mother.

Recent advances in genetic engineering make it another promising de-extinction method. Genome sequencing has become rapid and cheap, and powerful computer programs are being devised to reassemble degraded DNA from extinct organisms.

As specimens preserved in museums age, DNA in their tissues gets degraded into smaller and smaller snippets. This makes the task of reconstructing the entire genome's DNA sequence extremely difficult, if not impossible. Nonetheless, using high quality DNA from three well-preserved passenger pigeons (*Ectopistus migratorious*) stuffed in 1860,

Ben Novak, a molecular biologist at the University of California, Santa Cruz, CA, has so far sequenced 500 million of the ~1 billion DNA letters that make up the pigeon's genome.

He and George Church, a geneticist at Harvard Medical School, Boston, MA, have an unusual strategy to de-extinct the passenger pigeon. They plan to identify the genes responsible for key traits of the extinct bird, such as the long tail and orange breast, and splice them into a closely related extant species, the band-tailed pigeon (*Patagioena fasciata*). Successive rounds of this "genomic editing" would slowly replace band-tailed pigeon genes with specific passenger pigeon genes and generate a passenger pigeon over time, they say.

In 2002 Archer isolated degraded DNA from a museum specimen of the Thylacine (*Thylacinus cynocephalus*) or Tasmanian tiger, whose last representative died in 1936. Using these DNA snippets he plans to reconstruct the Thylacine genome, comprised of 3.5 billion DNA letters, and insert it into the egg of a related marsupial.

Writing in the April 5, 2013 issue of *Science*, Jacob Sherkow and Henry Greely, biomedical ethicists at Stanford University, Stanford, CA, consider the complicated ethical and legal implications of de-extinction. Would de-extinct species be considered endangered? Could they be patented? Would animals created by de-extinction suffer? Questions aside, they believe in the very near future someone will succeed in de-extincting a species.

Scientists are divided on whether or not to pursue de-extinction. Some are concerned that newly released species could damage the environment or be sources of new diseases. In many cases their habitats no longer exist. Susan Haig, president of the American Ornithological Union says the ivory-billed woodpecker (*Campephilus principalis*) is a better candidate for de-extinction than the passenger pigeon because it still has enough habitat in the southeastern US to make a comeback, while the pigeon's main food source, the American chestnut, is gone. Some like Archer believe we have a moral obligation to bring back species we have killed off.

Others just think it would be "really cool."

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