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SundayReview | OPINION

Tweaking Genes to Save Species

By HILLARY ROSNER APRIL 16, 2016

Boulder, Colo. — BIOTECHNOLOGISTS have engineered the mosquito that spreads the Zika virus to pass a lethal gene to its offspring. Another team of researchers has devised a way to spread sterility through the mosquito population, using a technique called gene drive to wipe out the offending insects.

If regulators approve this genetic tinkering, these insects could become a powerful weapon against the spread of mosquito-borne diseases to humans. But bugs like these, and the techniques used to create them, might have another role to play: helping to protect the earth's biodiversity.

This kind of genetic meddling makes many environmentalists deeply uncomfortable. Manipulating nature's DNA seems a hugely risky and ethically fraught way to help save the natural world. And yet, we may need to accept the risks.

On Hawaiian islands, for instance, avian malaria transmitted by mosquitoes is decimating native bird populations. Warmer temperatures have exacerbated the threat, allowing mosquitoes that carry the malaria parasite to invade higher-elevation areas that are the last holdouts for some birds. These losses ripple down through food chains, disrupting ecosystems.

But what if we could wipe out avian malaria without spraying toxic pesticides, by releasing male mosquitoes that have been genetically engineered to be sterile? Or that can't transmit the malaria parasite, thanks to an altered gene in their salivary glands?

And if we can design sterile mosquitoes, what about sterile rats?

On islands around the globe, invasive rodents are obliterating native plants and animals — many of which exist nowhere else. By some estimates, 90 percent of these archipelagos are plagued by nonnative rodents. Eradicating them could restore ecosystems and let evolutionary processes resume unfettered. The current method, poison, is a costly, labor-intensive one that also risks harm to native animals.

Scientists are developing advanced genetic techniques to ensure that all mouse offspring are male. No females, no babies, no more invasive rodents.

Such targeted conservation "would be transformative in our ability to deal with invasive rodents, which are a major extinction driver," says Josh Donlan, an ecologist, expert in island conservation, and director of the nonprofit Advanced Conservation Strategies.

Targeting invasive rodents and mosquitoes is only the beginning. New genomic techniques, including the gene-editing technology Crispr-Cas9, offer the tantalizing possibility of protecting at-risk species by targeting their persecutors. We might, for instance, be able to engineer a meeker version of the fungus that causes white-nose syndrome, the plague that is sweeping through bat colonies and destroying them. A less lethal version of the fungus might sicken the bats without killing them, and enable some to develop resistance.

These advanced genomic tools could also restore lost genetic diversity to shrinking populations of threatened or endangered species so that they are better equipped to adapt to environmental change or defend against potentially devastating pathogens.

One example is the black-footed ferret, an endangered weasel-like carnivoret once thought to be extinct that inhabits the grasslands of the West. The ferret's estimated wild population of 500 to 1,000 stems from just seven animals that were part of a captive breeding program more than 30 years ago.

Having brought these animals back from the brink, scientists now worry that the species, one of the most endangered of animals, may lack enough genetic diversity to survive long term.

One conservation organization has proposed bolstering the ferrets' genetic diversity with the aid of ferret DNA that was cryopreserved in the 1980s from animals whose genes are not represented in the current population. The group has submitted two proposals to the United States Fish and Wildlife Service to essentially bring back to life ferrets with rare genes.

"We're in a unique period where we've got the technology potentially in place to start changing the course for a lot of these species before they go extinct," says Ryan Phelan, executive director of Revive and Restore, the nonprofit group that submitted the plans.

The organization also supports de-extinction, the idea of using genomic technology to bring back vanished creatures like woolly mammoths and passenger pigeons. The same genetic tools involved in reanimating a mammoth may be tremendously useful in saving species that are still clinging on.

But many people — and many conservation biologists — argue that it is hubris to think that we can plan how this interference will unfold. History is full of examples of good intentions gone awry. In one famous case, Australians brought in cane toads in the 1930s to control an agricultural pest, the grey-backed cane beetle. These poisonous toads, which are native to South and Central America, have been wreaking havoc on local species ever since.

Ecosystems are messy, murky and highly complex. If anything is certain, it’s that genetically engineering nature will probably not go as intended.

Genomic solutions are not a replacement for traditional conservation strategies, like placing large tracts of land off limits to development, or reducing the widespread use of toxic pesticides and synthetic fertilizers, or ensuring there is enough clean water in lakes, rivers and wetlands to provide habitat for fish, birds and other creatures. There is no silver bullet for protecting the planet’s rich biodiversity; we must explore all available mechanisms.

We can’t save every species, of course. The planet is losing its biodiversity at an alarming rate, and there are too many species circling the drain. Conservation professionals acknowledge that we will need to perform a sort of conservation triage, a painful process of deciding which species to try to rescue and which to let go. As an increasing number slip away, we will face ever more difficult ethical decisions — not just about which species we want to save, but how far we are willing to go to save them, and even what “saving” them really means. Have we “saved” a species if it can survive only with sustained human intervention? Or if its genome is altered?

Last spring, Ms. Phelan and Kent Redford, a conservation biologist, convened a meeting in Sausalito, Calif., to address some of these questions, bringing together the worlds of biotechnology and conservation to discuss how the two might cooperate. A similar gathering is planned for this fall.

On a rapidly changing planet, conservation is increasingly a scramble for evolutionary resilience, a quest to help species survive the myriad challenges they face, to shore up the good stuff and handicap the bad. New genetic techniques could provide powerful weapons to the conservation arsenal, and a new path toward evolutionary resilience just when we need it most.

Correction: April 24, 2016

An opinion article last Sunday about the use of biotechnology to protect biodiversity described black-footed ferrets incorrectly. They are members of the order Carnivora; they are not rodents.

Hillary Rosner is a journalist who writes about science and the environment.

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