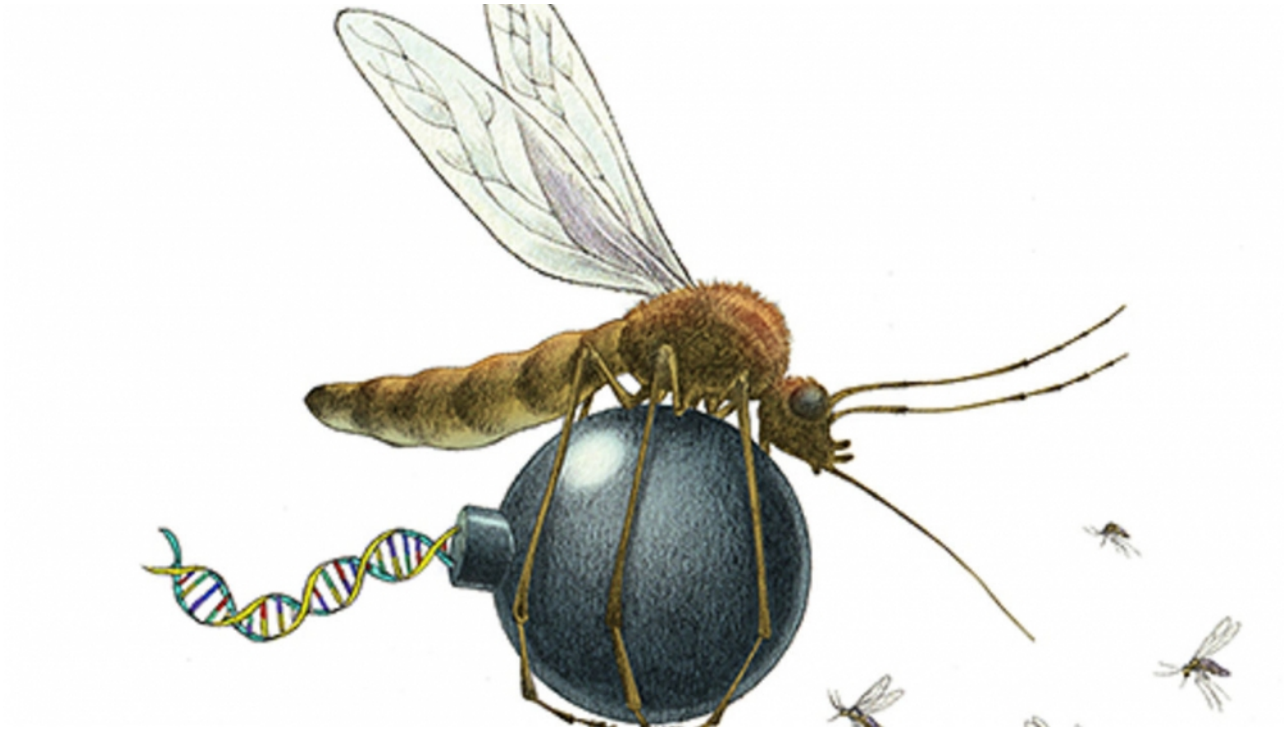
On the extinction of the species

# Gene drives promise great gains and great dangers

*Don't ban, don't rush*



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EXTINCTIONS ARE seldom cause for celebration. Humans are wiping out species at a frightening rate, whether hunting them into history or, far more threateningly, damaging the habitats on which they depend. But occasionally, the destruction is warranted. Smallpox was officially eradicated in 1980, and no one

laments the fate of the virus that caused it; campaigns to save the virus that causes polio are thin on the ground. How, then, to think about a new technology that will make driving a species to extinction far easier?

That technology is known as a gene drive, so called because it uses genetic engineering to drive certain traits through a population. Those characteristics need not be deleterious: they might include greater resilience to disease among crops or, perhaps, greater tolerance to warming waters on the part of corals. But if the desired trait were harmful, gene drives could in theory make a species extinct. And if the species in question were the three types of mosquito responsible for transmitting malaria, proponents reckon it could save close to half a million lives a year, many of them children. The same approach could be used against other vector-borne diseases such as Lyme disease, Zika and dengue fever. Gene drives also offer conservationists a potential weapon against invasive species such as foxes, mice, rabbits and rats, whose proliferation threatens native species in some parts of the world. (Humans are unsuited to gene drives, which work best in species that reproduce quickly, with many offspring.)



Normally genes have a 50:50 chance of being passed on during reproduction. Gene drives tilt the evolutionary scales. One area of research focuses on genes that can copy themselves to the second in a pair of chromosomes, ensuring that they will be inherited by all offspring. Biasing inheritance in this way is what makes it possible to push a desired mutation, whether harmful or beneficial, through a population—controlling its level, and potentially wiping it out altogether (see article).

Like many technologies, however, gene drives may lead to bad outcomes as well as good. Opponents think the technology is simply too dangerous to contemplate

using. Some worry about playing God—though discarding an opportunity to save millions of lives in order to defend a principle is itself unethical. Others warn that the technology could entrench the power of big agritech firms. But that is an argument for ensuring competition, not for ending research.

Three other concerns are less easily handled. One is practical: removing a species from the food chain could have unintended consequences, particularly if gene drives can move to a closely related species. Another relates to governance. Genetically modified crops can be kept relatively contained; animals carrying gene drives could be mobile and respect no borders. One country's decision to use gene drives will have consequences for its neighbours. A third worry concerns nefarious uses of the technology, and not only by states. A mosquito, engineered to inject toxins, could be used as a weapon.

Faced with such risks, some want simply to call a halt. An attempt to impose a moratorium on gene drives was rejected by governments in 2016 at a United Nations meeting on biodiversity. Another such meeting, which takes place this month, will debate proposals that could hinder field trials. But putting the brakes on research may impose real costs: not just the annual toll taken by malaria and other killers before an answer is found, but also slower progress towards making gene drives safer. Since the decision in 2016 researchers have made advances on drives that die out over time, for example. That sort of approach could go some way to solving the practical concerns. Given that it will be eight years or so before a gene drive is expected to be ready for field trials, more can be done in the interim to minimise its potential to cause harm.

That will require a more robust approach to governance, too. The ideal would be a set of norms for states and funders to adhere to. These might include rules on the mandatory registration of gene-drive trials; on stringent sequencing of gene-drive tests, as they progress from laboratory environments to field trials; on ways for neighbouring states to monitor standards in any country that wanted to use gene drives; and on agreed criteria for the approval of any release, such as the existence of an unmodified population in captivity.

Rules or not, rogue states and other malevolent actors may still want to use gene drives for malicious purposes. And, like many new technologies, gene drives do not

require big organisations in order to be made to work. Prudent countries ought to plan accordingly. America's government, rightly, justifies some of its gene-drive research as a way to develop better defences against harmful uses. In the future, improved gene-sequencing technologies should make it easier to spot species carrying malevolent drives.

These risks underline why gene drives must be managed carefully. They ought not, however, to obscure the prize on offer if the technology can be made to work well. Humans are already radically and heedlessly reshaping the planet. Gene drives would further enhance humanity's ability to shape nature—but with the potential to do so precisely, efficiently and for the better.

*This article appeared in the Leaders section of the print edition under the headline "On the extinction of species"*

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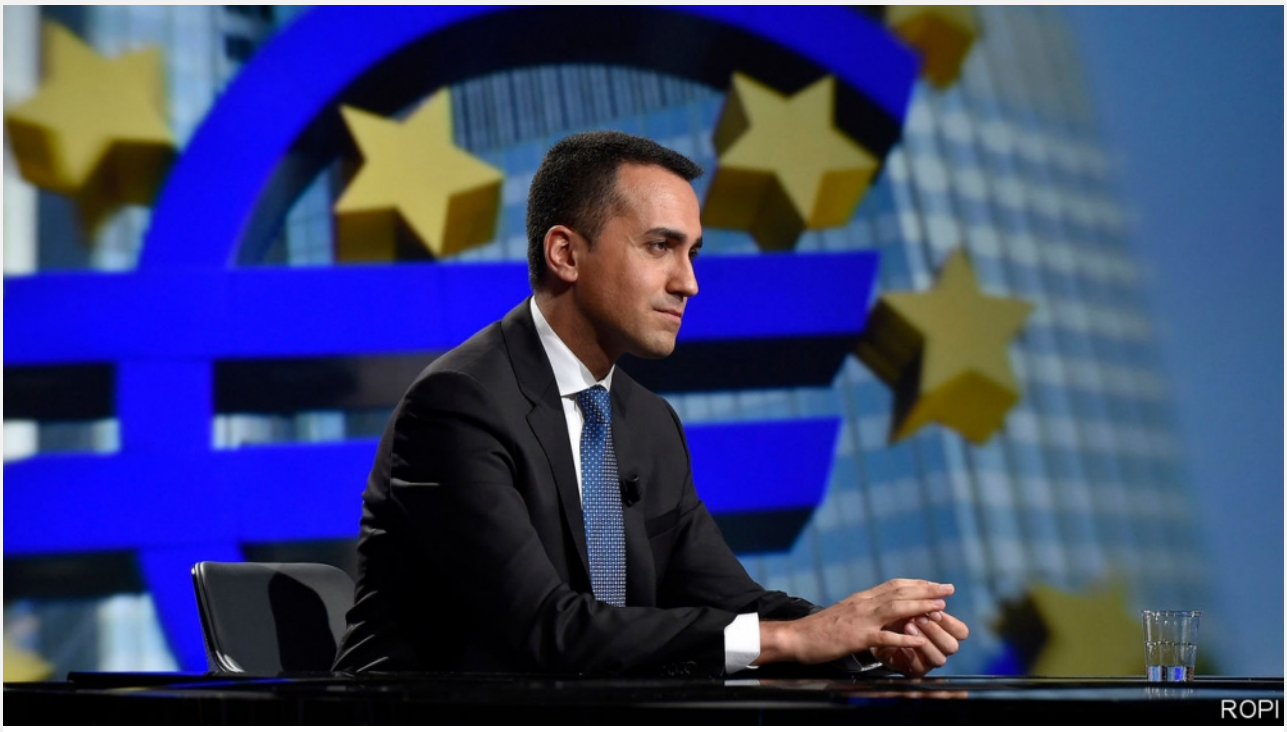


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