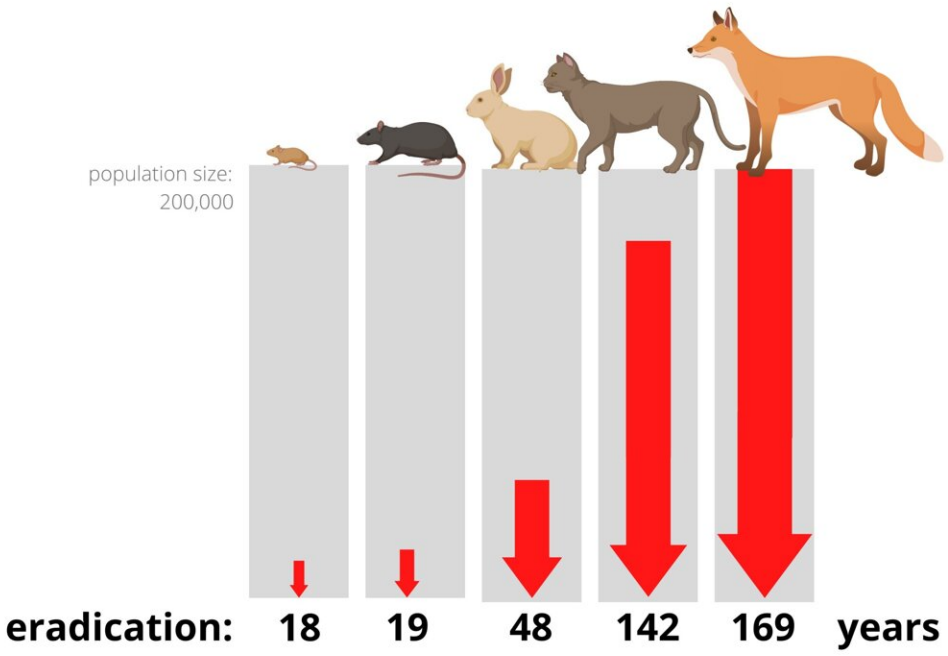
Genetically-enhanced biocontrols could help fight large invasive mammals

July 8 2022



Times to eradication in mice and other invasive mammals using genetic biocontrols. Credit: Birand et al.

Invasive alien mammals can have catastrophic impacts on native flora

and fauna, causing species extinctions and driving profound environmental change. Classical control methods such as poison baiting, trapping, or hunting are currently not feasible on a large scale, which is why researchers are looking for alternatives.

CRISPR-based genome engineering is often seen as a "silver bullet" for pest control. Despite the increasing interest in the development of this technology for invasive mammals like mice, rats, rabbits, feral cats, and foxes, studies have so far only focused on mice.

Scientists have been pondering whether genome editing technologies could help eradicate larger mammals, and if so, how long it would take.

In order to address these questions, a team of researchers from the University of Adelaide developed a mathematical model able to simulate the impact of gene drives on mammal populations at a landscape scale. Published in *NeoBiota*, their study is the first to estimate the time it would take to eradicate long-lived alien mammals.

Using CRISPR-Cas9 technology, the simulated gene drive relies on "molecular scissors" inserted into the Y-chromosome that target and slice up the X-chromosome at the right time during meiosis, so that only Y-chromosome carrying sperms are functional and can successfully fertilize the egg. In this way, the drive carrying males should only produce sons that also carry the molecular scissors on their Y-chromosome. Over multiple generations, females will become rarer and produce fewer offspring; as a result, the population size will fall.

This "X-shredder" drive has been successfully developed and demonstrated to suppress cage populations of malaria-carrying mosquitos, but has not yet been developed in mammals. The model shows that the X-shredder drive could potentially achieve landscape-scale eradication of mice, rats, rabbits, feral cats, and red foxes, but the

probability of success and the time it would take to eradicate them vary greatly.

The researchers investigated the ability of the X-shredder drive to eradicate a population of 200,000 individuals of each species. "CRISPR-based gene drives offer novel solutions for controlling invasive alien species, which could ultimately extend eradication efforts to continental scales," they concluded.

The method could be effective in small-sized pests, such as rodents and rabbits. The expected time to eradication is 18 years for mice, 19 years for rats, and 48 years for rabbits, with 90% population suppression achieved in around half those times.

However, the results suggest that gene drives are not a one-size-fits-all solution: they might not be so useful in larger species like cats and foxes.

"The probability of eradicating feral cats with gene drives is identical to flipping a coin, 50/50; and provided that the coin lands on the right side, it would take about 140 years to get rid of them," says Dr. Aysegul Birand, part of the research team. "The probability of eradication is higher for foxes, but the wait is even longer."

More information: Aysegul Birand et al, Scalability of genetic biocontrols for eradicating invasive alien mammals, *NeoBiota* (2022). DOI: 10.3897/neobiota.74.82394

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