gene drive monitor
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Bulletin
October 2024

A horizon scanning survey of gene drive development

Covering research up to 1 September 2024.
For supporting information and references see genedrivemonitor.org

Introduction

The emergence of gene drive technology opens up unprecedented prospects of modifying, suppressing, or even eliminating wild species to serve human purposes. The consequences of choosing to go down this path are very difficult to foresee, especially in the longer term.

The findings below are an output of the Gene Drive Monitor project, which tracks and assesses research in this field on an ongoing basis, and analyses risks and technical issues.

Key findings

- **Gene drives are under development or have been proposed in at least 82 species, with a further 9 taxonomic groups cited as potential targets.** Laboratory work on gene drive construction has so far taken place in at least 18 species, while preliminary laboratory work and/or theoretical work (including modelling), has taken place for an additional 46 targets.
- **The majority of gene drive proposals are based on eradication/suppression approaches.** Only a very few projects are aiming to modify characteristics of species or populations in the wild.
- **Commonly cited goals for gene drive research are 'suppression' of wild species designated as agricultural pests (e.g. fruit-flies), disease vectors (e.g. mosquitoes), or invasive species (e.g. mice).** A less commonly cited goal is the modification of disease vectors to inhibit the spread of disease.
- **Concerns about the potential for 'dual use' or malicious use of gene drive insects have been raised,** for example by the US National Academies of Science Engineering and Medicine.
- **There are proposals to target a diverse range of species and taxonomic groups, ranging from the feral cat to the sea lamprey, the common wasp, the grey squirrel, and the European starling.** This shows that intentions go far beyond mosquitoes and mice.
- **No field trials of gene drives have yet taken place.** The Target Malaria consortium stated that they hope to carry out 'tangible field trials of gene drive for malaria vector control in Africa within the next five years' (May 2024).

Recent developments

- **Research published in June 2024 demonstrated the first functional gene drive systems in a plant,** *Arabidopsis thaliana*. It is likely that these results will broaden the scope of gene drive research, for example to target agricultural weeds.
- **A gene drive has now been developed in the Mediterranean fruit fly, *Ceratitis capitata*,** with the aim of 'suppressing' or eradicating populations to reduce its impacts on crops.
- **A so called 'Y-shredder' sex ratio distorter system has been constructed** in *Anopheles gambiae*, which generates a female bias. This was not considered useful in this species but could perhaps be so for other pest species.
- **The malaria vector *Anopheles farauti* has been proposed as a target.** One rationale offered is that 'the presence of genetically isolated populations in Australia would allow the development of a gene drive to target populations for field trials in a developed country with well-established and robust regulatory processes.'
- ***Anopheles gambiae* mosquitoes modified to express anti-CRISPR proteins have been shown to 'inhibit' homing CRISPR gene drives in large cage trials.** This research was partly funded by DARPA and the US Department of Defense.

Motivations for gene drive research

- **In insects, gene drives are under development or have been proposed for 44 insect targets.**
  - **The majority of these are agricultural pests, 24 in total, including five livestock pests** or livestock disease vectors, some of which are also human disease vectors.
  - **16 are vectors of human disease in particular malaria.**
  - **6 insect species only are proposed, at least in part, because of their impacts on biodiversity as invasive species.**
- **Prevention of biodiversity loss appears to be a more significant driver for gene drive development in vertebrates.** 19 of the 20 vertebrate targets relate, at least in part, to controlling or eliminating invasive species for biodiversity purposes, especially mammals.

Species where a gene drive has been built and is at least partly functional

Taxonomic group	Species (grey = no intention to release)	Motivation
INSECTS - Mosquitoes	Aedes aegypti Anopheles coluzzii Anopheles gambiae Anopheles stephensi Culex quinquefasciatus	Vector V V V V
INSECTS - Diptera (true flies) – excluding mosquitoes	Ceratitis capitata (mediterranean fruit fly) Drosophila melanogaster Drosophila suzukii (spotted winged drosophila)	Agriculture A
INSECTS - Lepidoptera (moths and butterflies)	Plutella xylostella (diamondback moth)	A
MAMMALS	Mus musculus (house mouse)	Biodiv + R&D
FUNGI	Fusarium graminearum Saccharomyces cerevisae (brewers yeast) Candida albicans	A
PLANTS	Arabidopsis thaliana	R&D

Number of targets where a gene drive has been proposed

Kingdom (Phylum)	Class (Order/Family)	Number of target species
ANIMALS - Arthropods	INSECTS – Mosquitoes	13
	Diptera (true flies) excl. mosquitoes	10 (incl. 1 intended for release)
	Lepidoptera	3
	Hemiptera	5
	Coleoptera	4
	Hymenoptera	5
	Arachnids	1
Vertebrates	Mammals	13
	Others	6
Molluscs		1
Nematodes		1 (not intended for release)
Fungi		4 (incl. 2 not intended for release)
Plants		16