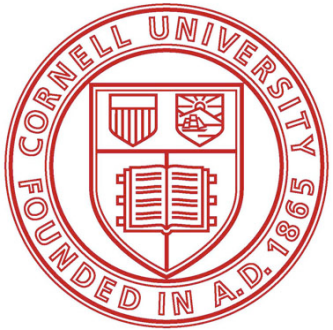
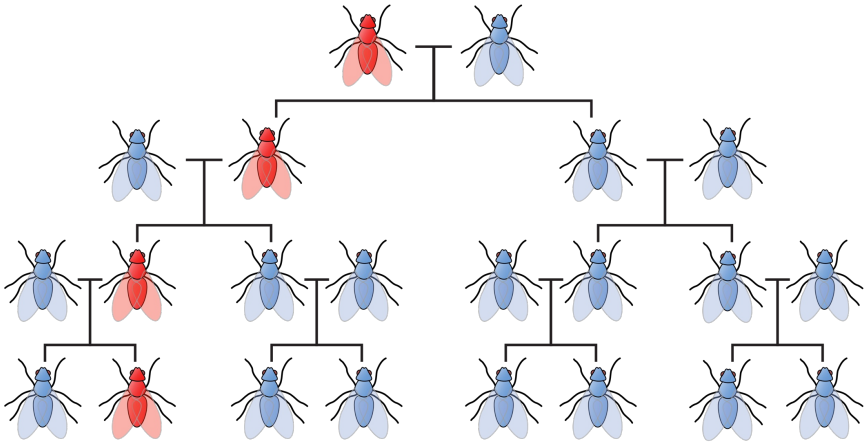
Can we predict the outcome of CRISPR gene drive releases?

Philipp W. Messer



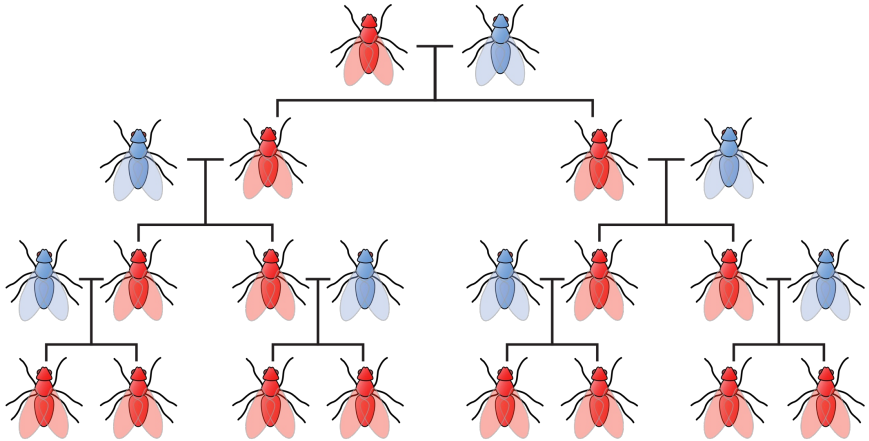
Department of Computational Biology
Cornell University

Normal inheritance

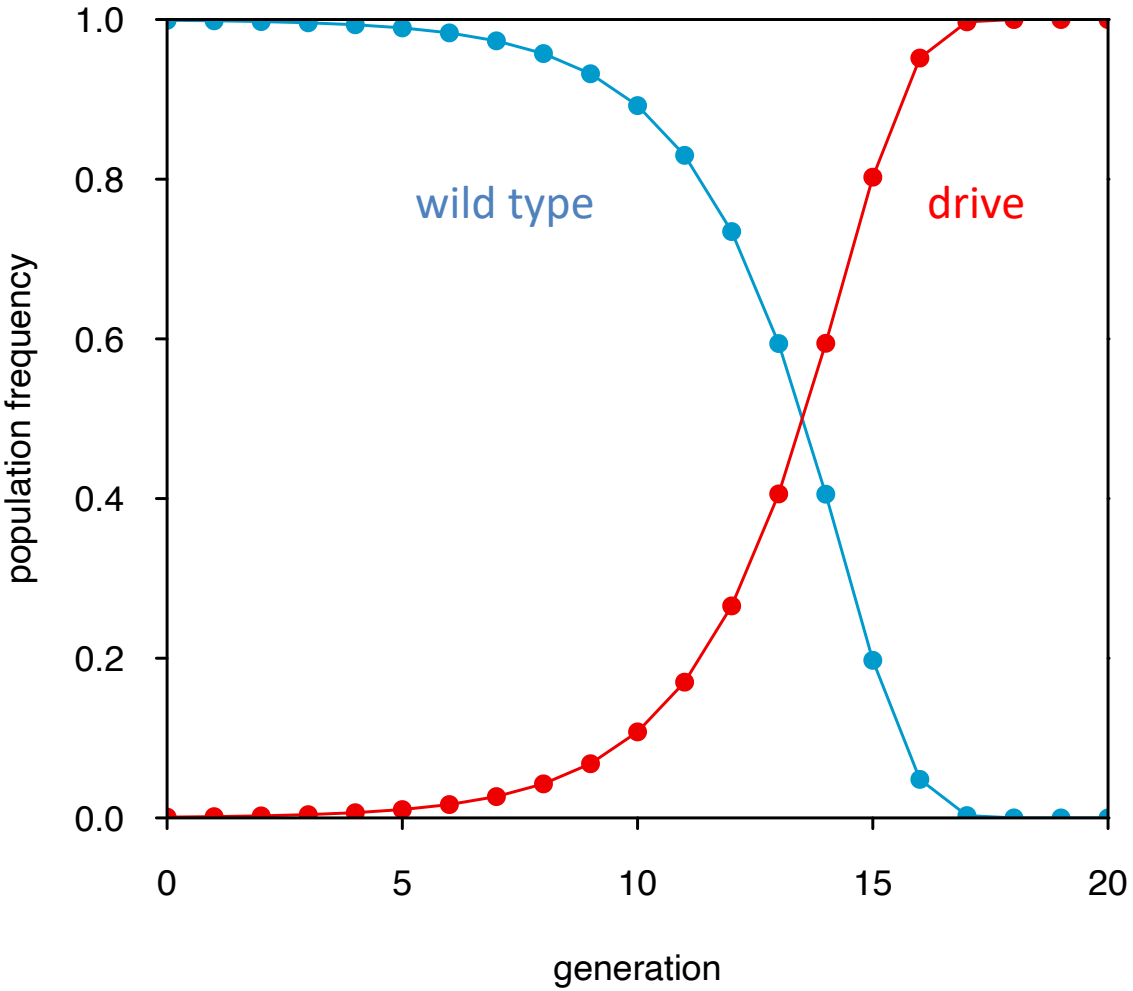


Altered gene does not spread

Gene drive inheritance

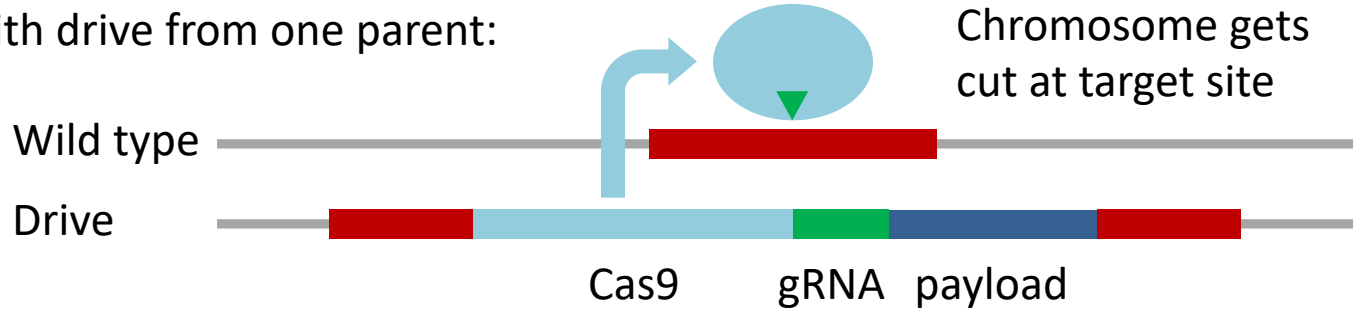


Altered gene is always inherited

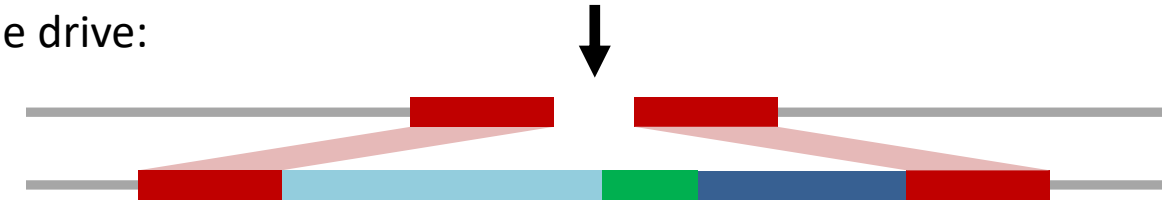

1.0
0.8
0.6
0.4
0.2
0.0
population frequency
wild type
drive
0
5
10
15
20
generation

CRISPR homing gene drives

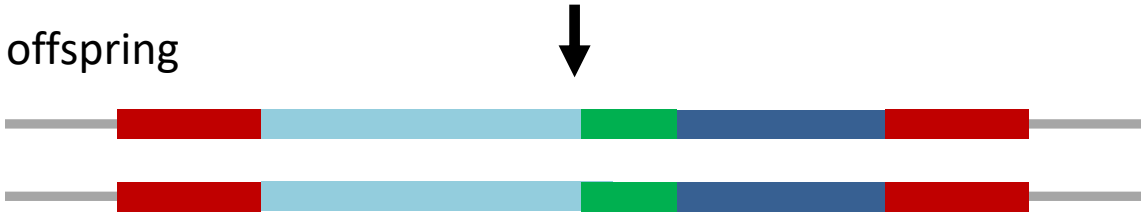
Individual with drive from one parent:



Repair by “copying” the drive:



Will pass on drive to all offspring



PNAS

Highly efficient Cas9-mediated gene drive for population modification of the malaria vector mosquito *Anopheles stephensi*

Valentino M. Gantz[a,1], Nijole Jasinskiene[b,1], Olga Tatarenkova[b], Aniko Fazekas[b], Vanessa M. Macias[b], Ethan Bier[a,2], and Anthony A. James[b,c,2]

nature biotechnology

A CRISPR–Cas9 gene drive targeting *doublesex* causes complete population suppression in caged *Anopheles gambiae* mosquitoes

Kyros Kyrou[1,2], Andrew M Hammond[1,2], Roberto Galizi[1], Nace Kranjc[1], Austin Burt[1], Andrea K Beaghton[1], Tony Nolan[1] & Andrea Crisanti[1]

SCIENTIFIC
AMERICAN

BIOLOGY

Harnessing the Power of Gene Drives to Save Wildlife

New gene-editing technology breakthroughs could help save native species from the blight of invaders—but at what risk?

By Jason G. Goldman on September 14, 2016 **Véalo en español**

BIOTECHNOLOGY

US agencies tackle gene drives

National-security community studies risks of method to quickly spread DNA modifications.

BY EWEN CALLAWAY

The JASONs, a group of elite scientists that advises the US government on national security, has weighed in on issues ranging from cybersecurity to renewing country's nuclear arsenal. But at a meeting in June, the secretive group took stock of a new threat: gene drives, a genetic-engineering technology that can swiftly spread modifications through entire populations and could help vanquish malaria-spreading mosquitoes.

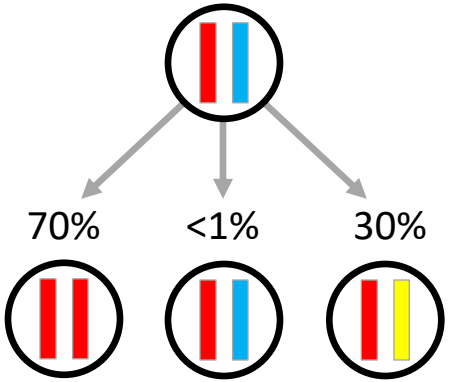
That meeting forms part of a broader US national security effort this year to grapple with the possible risks and benefits of a technology that could drive species extinct and alter whole ecosystems. On 19 July, the US Defense Advanced Research Projects Agency (DARPA) announced US$65 million in funding to scientists studying gene-editing technologies; most of the money will be for work on gene drives. And a US intelligence counterpart to DARPA is planning to fund research into detecting organisms containing gene drives and other modifications.

"Every powerful technology is a national security issue," says Kevin Esvelt, an evolutionary engineer at the Massachusetts Institute of Technology in Cambridge, who won DARPA funding to limit the spread of gene drives.

Evolution of resistance

♀ embryo

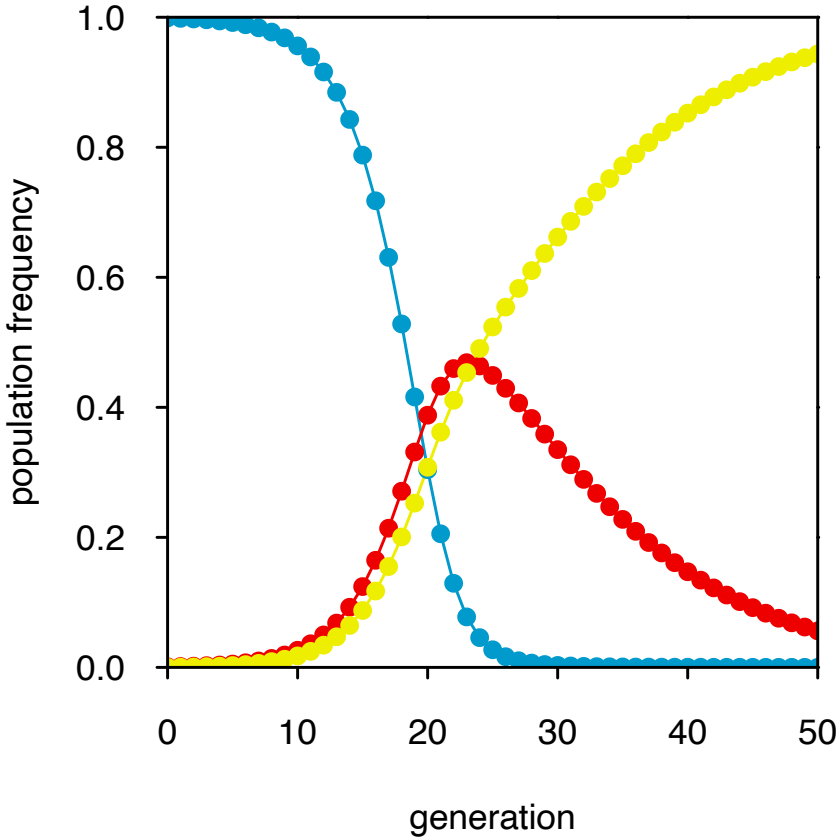
♀ germline cell



wild-type

drive

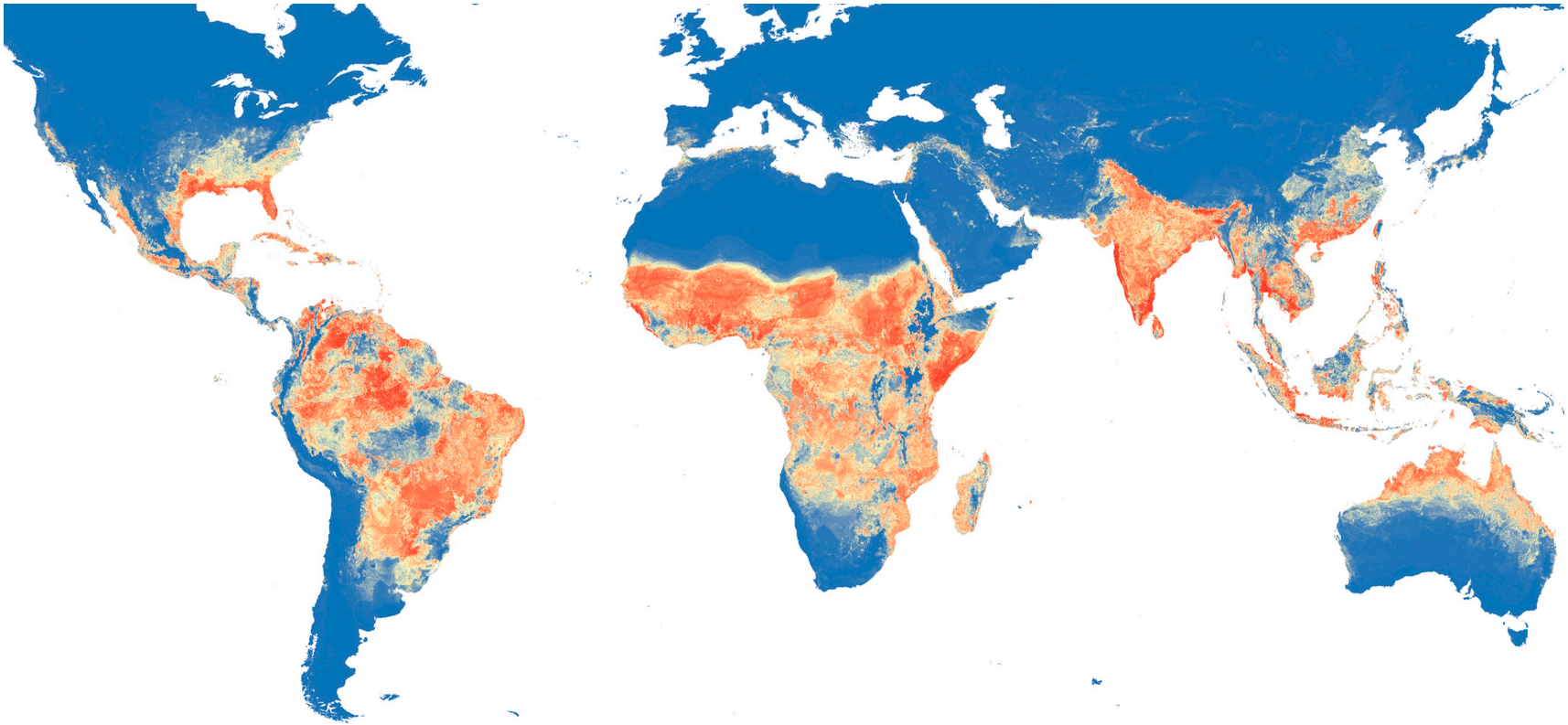
resistance



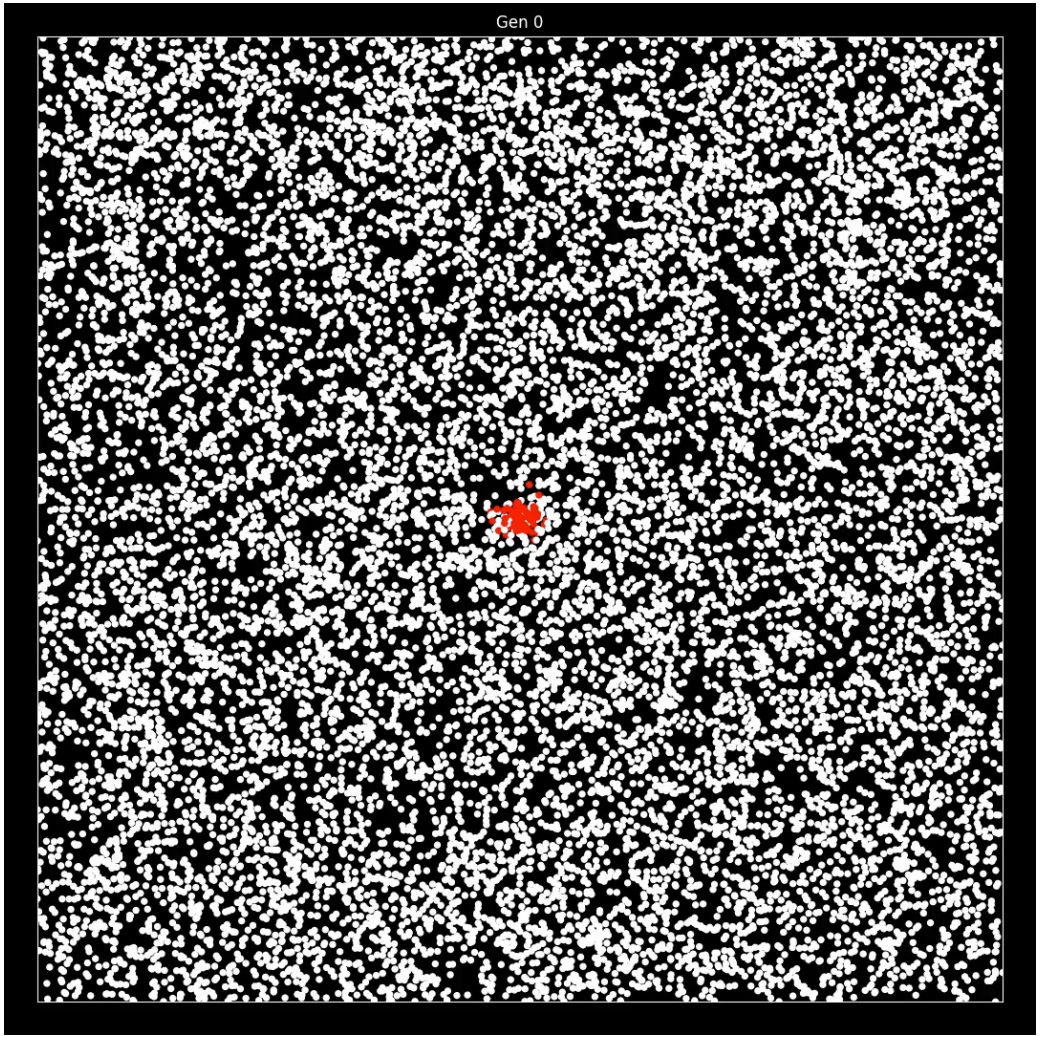

Cage 1

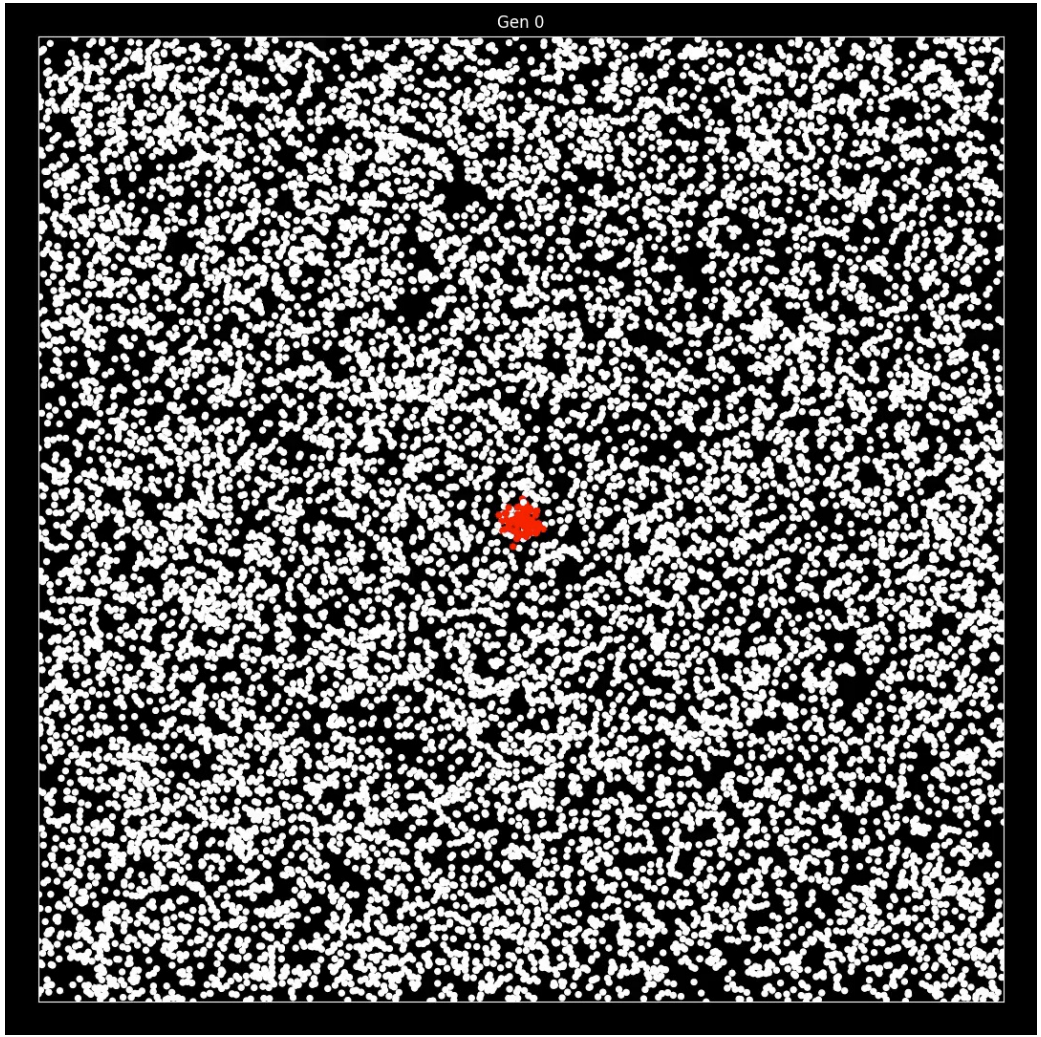
Sarkaria Arthropod Research Laboratory

Global distribution of *Aedes aegypti* mosquitoes:



Kraemer et al. *eLife* 2014


Gen 0


Gen 0

Summary

- CRISPR gene drives could provide a powerful tool for manipulating or suppressing populations
- Evolution of resistance poses a serious obstacle to any drive strategy
- Our current ability to predict the outcome of a drive release is, at best, rudimentary

NIH National Institute of General Medical Sciences

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