



NC STATE



NC STATE

Not All Gene Drives Are Created Equal

Fred Gould
Genetic Engineering & Society Center
NC State University

Drive Category	Threshold	Can spread high fitness cost	Temporally limited	Spatially limited	Resistance to drive
Standard Homing Drive	No (except special cases)	Yes	No	No	Yes In most cases
Cleave/Replace TARE/Medea	Low- if no fitness cost	No	No	Depends on fitness cost	Possible
<i>Wolbachia</i>	Low- if no fitness cost	No	No	Depends on fitness cost	Yes
Killer-Rescue Split-Homing Daisy Chain	No	No	Yes	No	Possible
Underdominance	At least 27%	No	No	Yes	Possible
Tethered Homing (with Underdominance)	At least 27%	Yes	No	Yes	Yes In most cases

Drive Category	Threshold	Can spread high fitness cost	Temporally limited	Spatially limited	Resistance to drive
Standard Homing Drive	No (except special cases)	Yes	No	No	Yes In most cases
Cleave/Replace TARE/Medea	Low- if no fitness cost	No	No	Depends on fitness cost	Possible
<i>Wolbachia</i>	Low- if no fitness cost	No	No	Depends on fitness cost	Yes
Killer-Rescue Split-Homing Daisy Chain	No	No	Yes	No	Possible
Underdominance	At least 27%	No	No	Yes	Possible
Tethered Homing (with Underdominance)	At least 27%	Yes	No	Yes	Yes In most cases

Drive Category	Threshold	Can spread high fitness cost	Temporally limited	Spatially limited	Resistance to drive
Standard Homing Drive	No (except special cases)	Yes	No	No	Yes In most cases
Cleave/Replace TARE/Medea	Low- if no fitness cost	No	No	Depends on fitness cost	Possible
<i>Wolbachia</i>	Low- if no fitness cost	No	No	Depends on fitness cost	Yes
Killer-Rescue Split-Homing Daisy Chain	No	No	Yes	No	Possible
Underdominance	At least 27%	No	No	Yes	Possible
Tethered Homing (with Underdominance)	At least 27%	Yes	No	Yes	Yes In most cases

Drive Category	Threshold	Can spread high fitness cost	Temporally limited	Spatially limited	Resistance to drive
Standard Homing Drive	No (except special cases)	Yes	No	No	Yes In most cases
Cleave/Replace TARE/Medea	Low- if no fitness cost	No	No	Depends on fitness cost	Possible
<i>Wolbachia</i>	Low- if no fitness cost	No	No	Depends on fitness cost	Yes
Killer-Rescue Split-Homing Daisy Chain	No	No	Yes	No	Possible
Underdominance	At least 27%	No	No	Yes	Possible
Tethered Homing (with Underdominance)	At least 27%	Yes	No	Yes	Yes In most cases

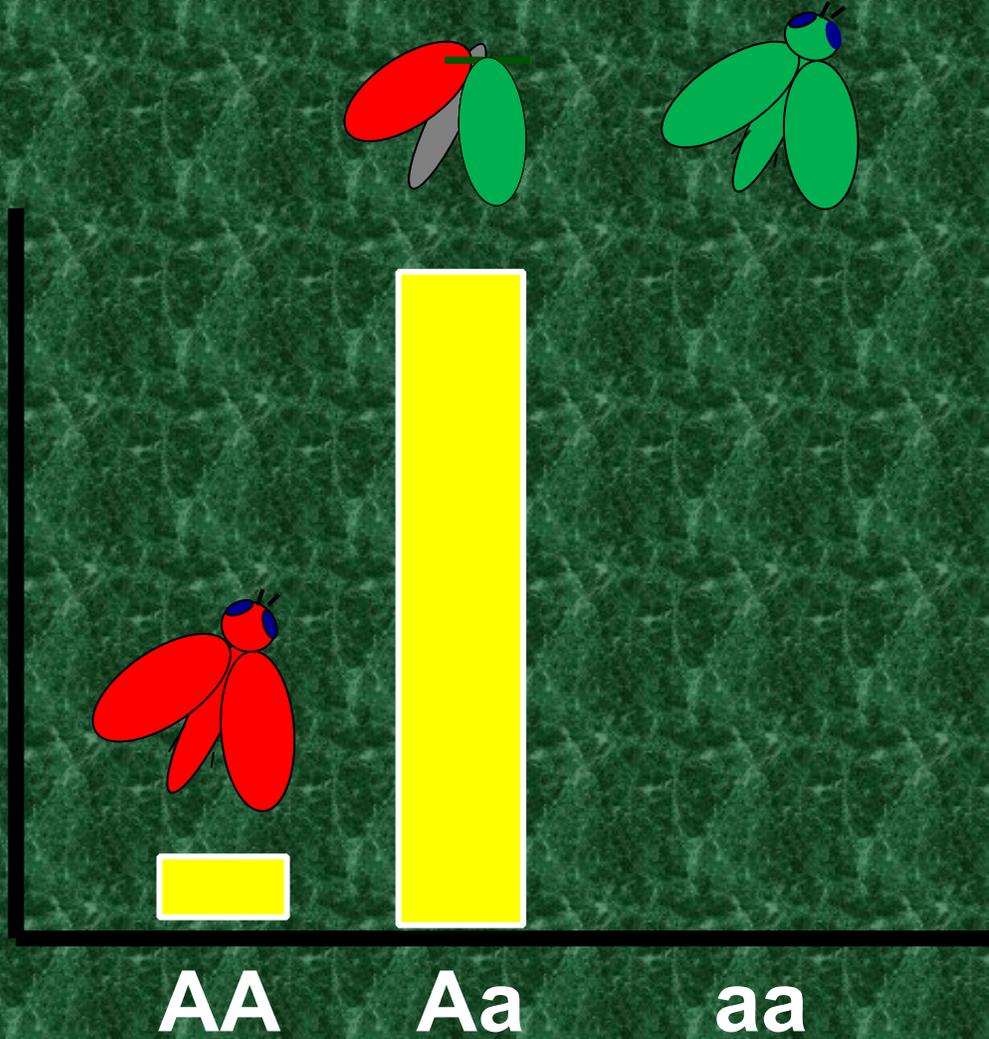
Drive Category	Threshold	Can spread high fitness cost	Temporally limited	Spatially limited	Resistance to drive
Standard Homing Drive	No (except special cases)	Yes	No	No	Yes In most cases
Cleave/Replace TARE/Medea	Low- if no fitness cost	No	No	Depends on fitness cost	Possible
<i>Wolbachia</i>	Low- if no fitness cost	No	No	Depends on fitness cost	Yes
Killer-Rescue Split-Homing Daisy Chain	No	No	Yes	No	Possible
Underdominance	At least 27%	No	No	Yes	Possible
Tethered Homing (with Underdominance)	At least 27%	Yes	No	Yes	Yes In most cases

Drive Category	Threshold	Can spread high fitness cost	Temporally limited	Spatially limited	Resistance to drive
Standard Homing Drive	No (except special cases)	Yes	No	No	Yes In most cases
Cleave/Replace TARE/Medea	Low- if no fitness cost	No	No	Depends on fitness cost	Possible
<i>Wolbachia</i>	Low- if no fitness cost	No	No	Depends on fitness cost	Yes
Killer-Rescue Split-Homing Daisy Chain	No	No	Yes	No	Possible
Underdominance	At least 27%	No	No	Yes	Possible
Tethered Homing (with Underdominance)	At least 27%	Yes	No	Yes	Yes In most cases

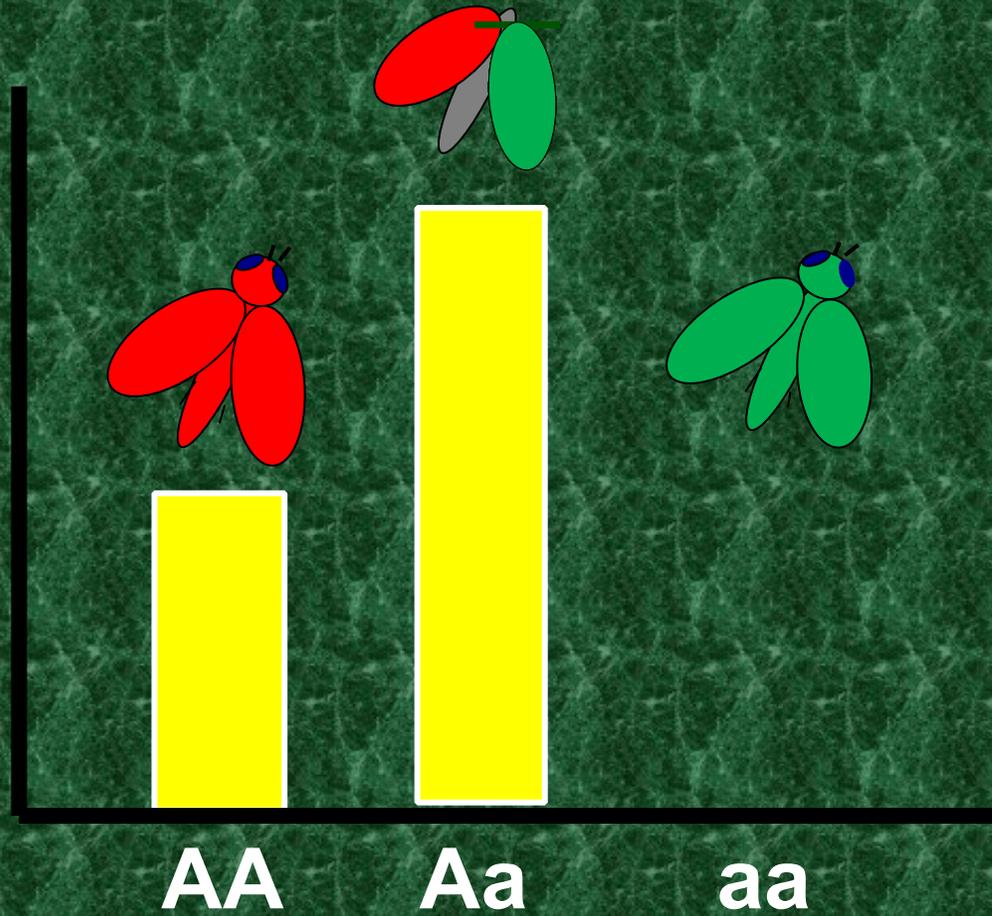
Underdominance for Gene Drive

**Spatially
Limited Spread**

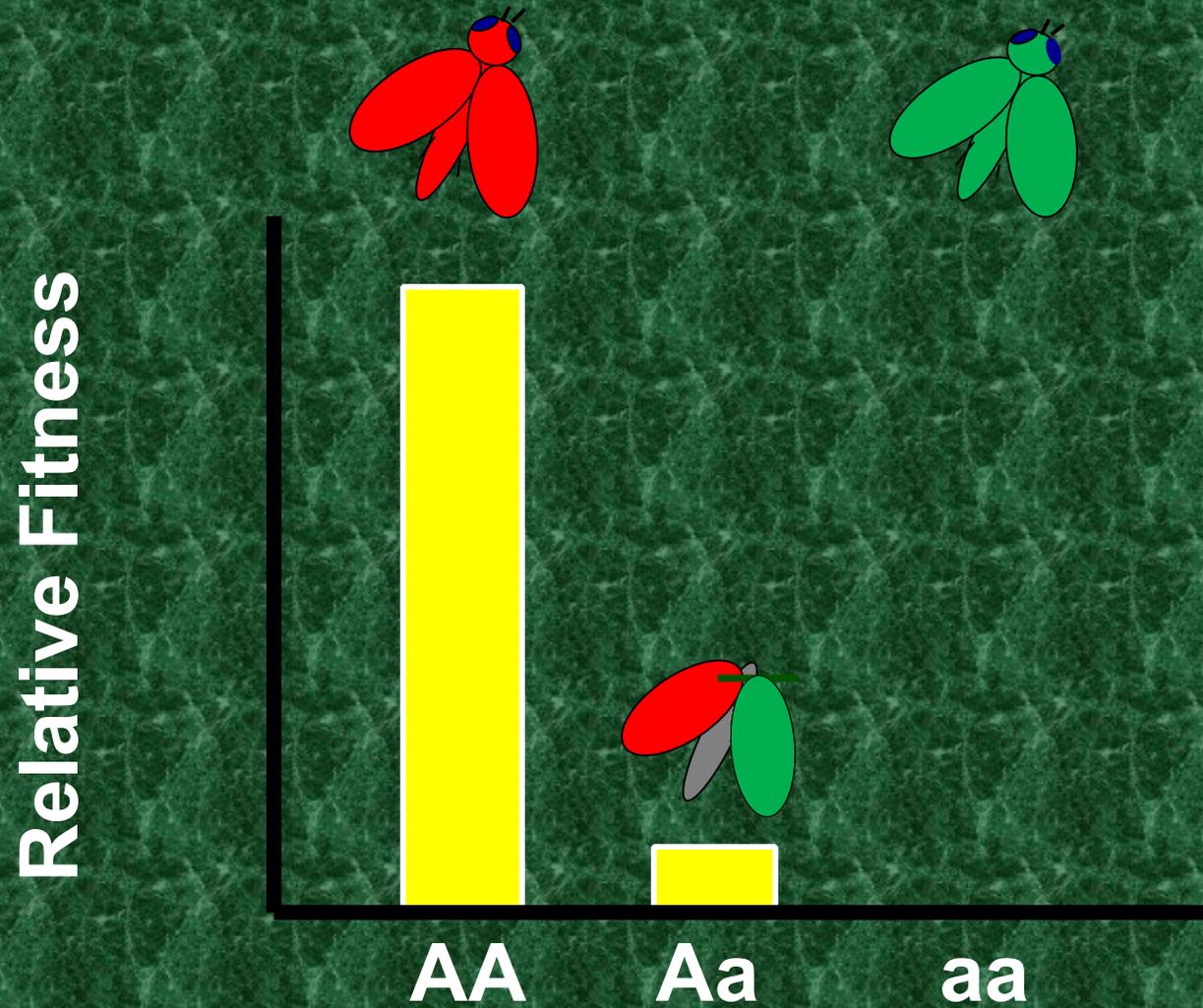
Relative Fitness



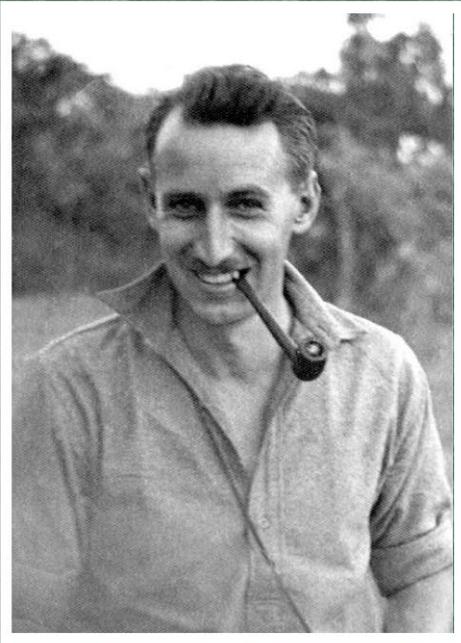
Relative Fitness



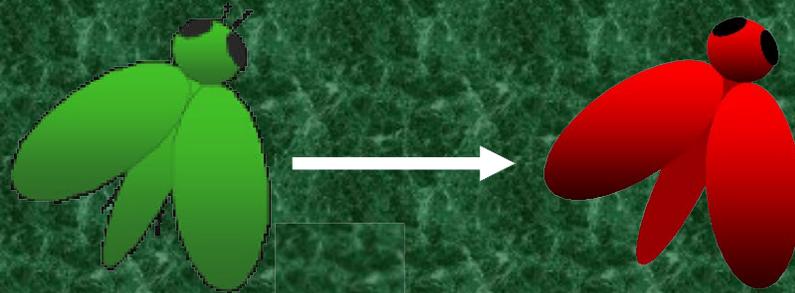
Underdominance



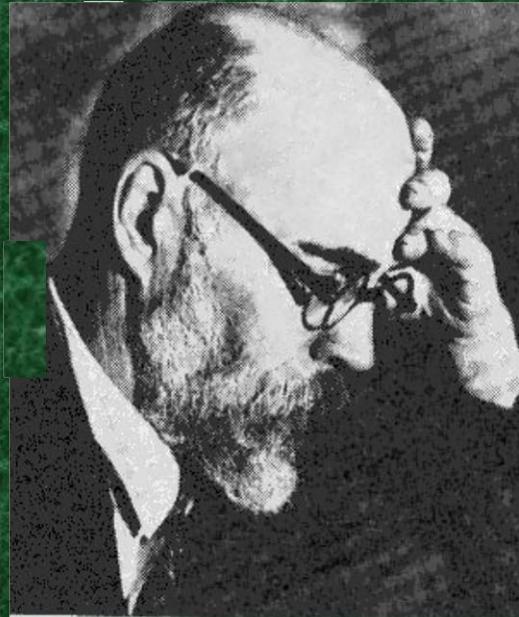
Strain Replacement



F.L. Vanderplank
1940's
Hybrids of
Tsetse fly
species

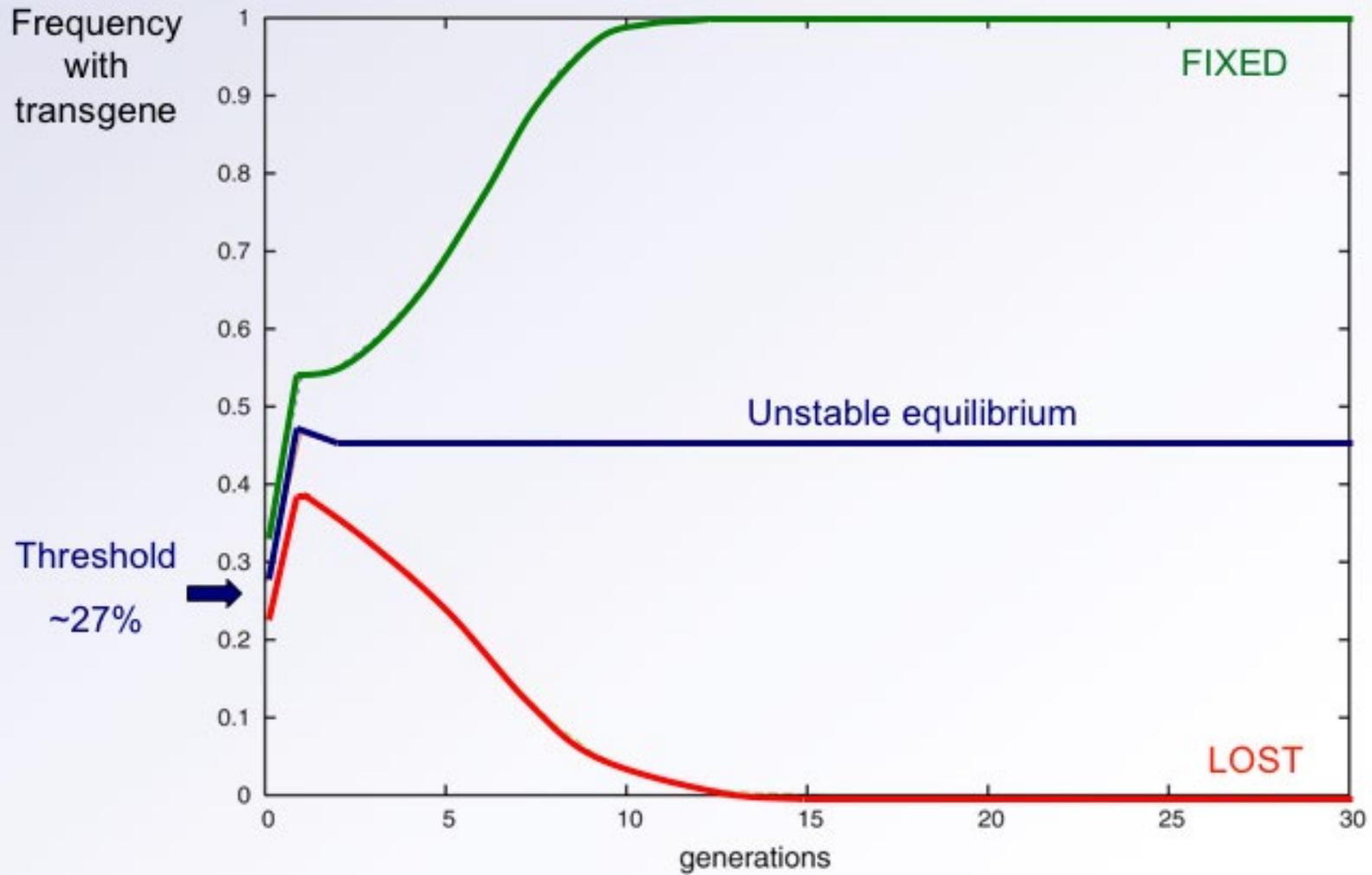


Chris Curtis
UK
1960's



A. S. Serebrovski
Soviet Union - Lysenko era
1940's Translocations

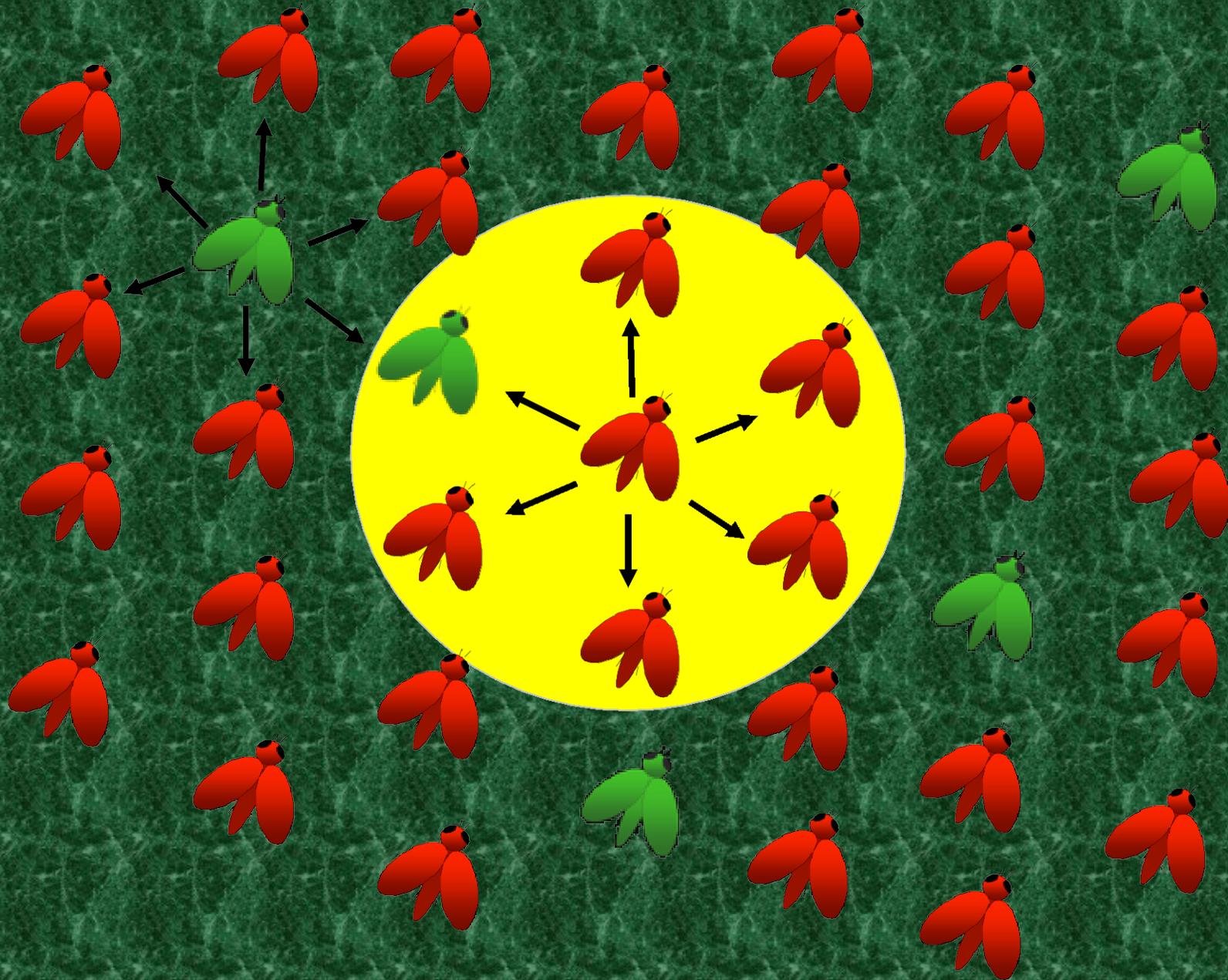
Engineered Underdominance – No cost



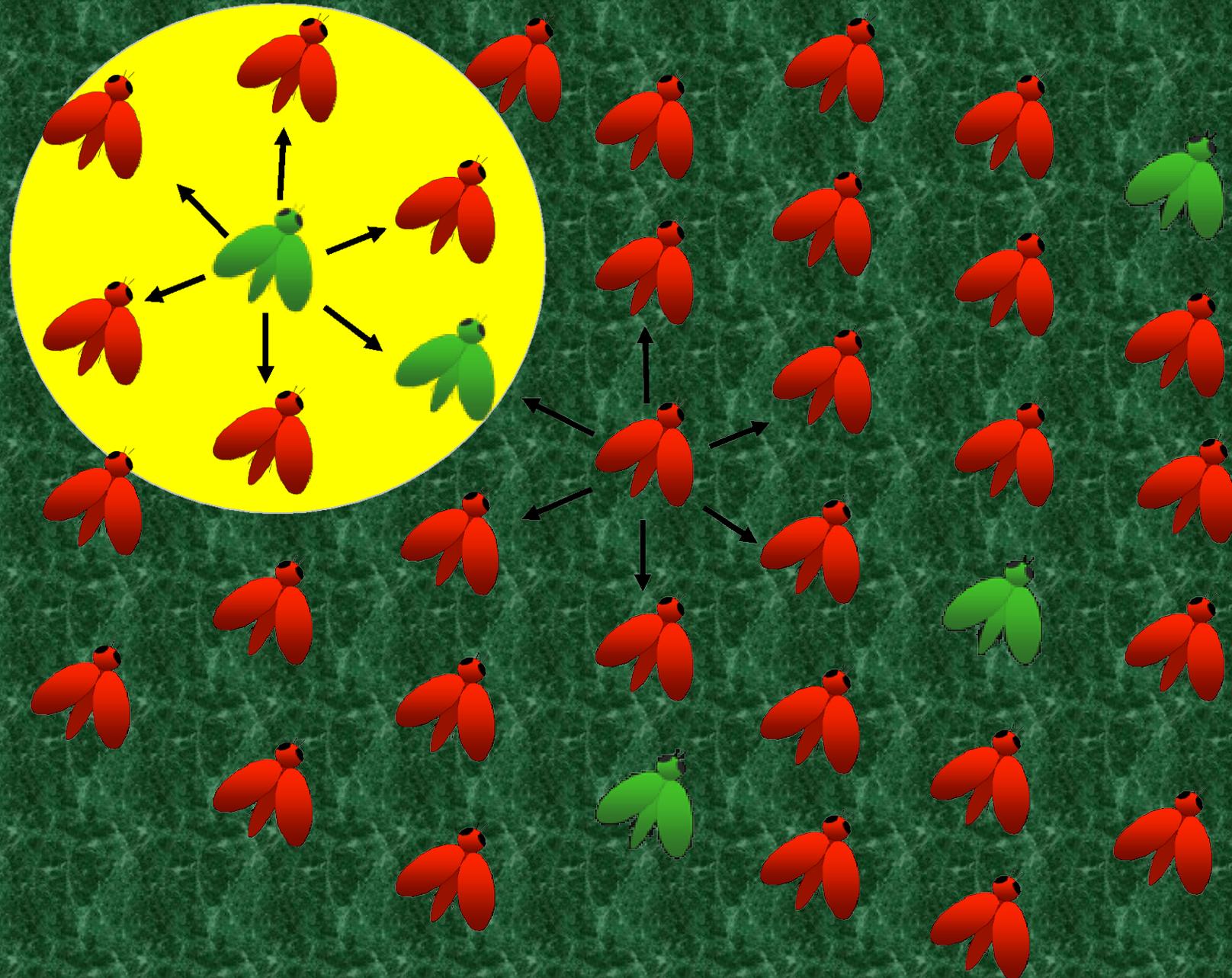
Large numbers of transgenic genotypes released

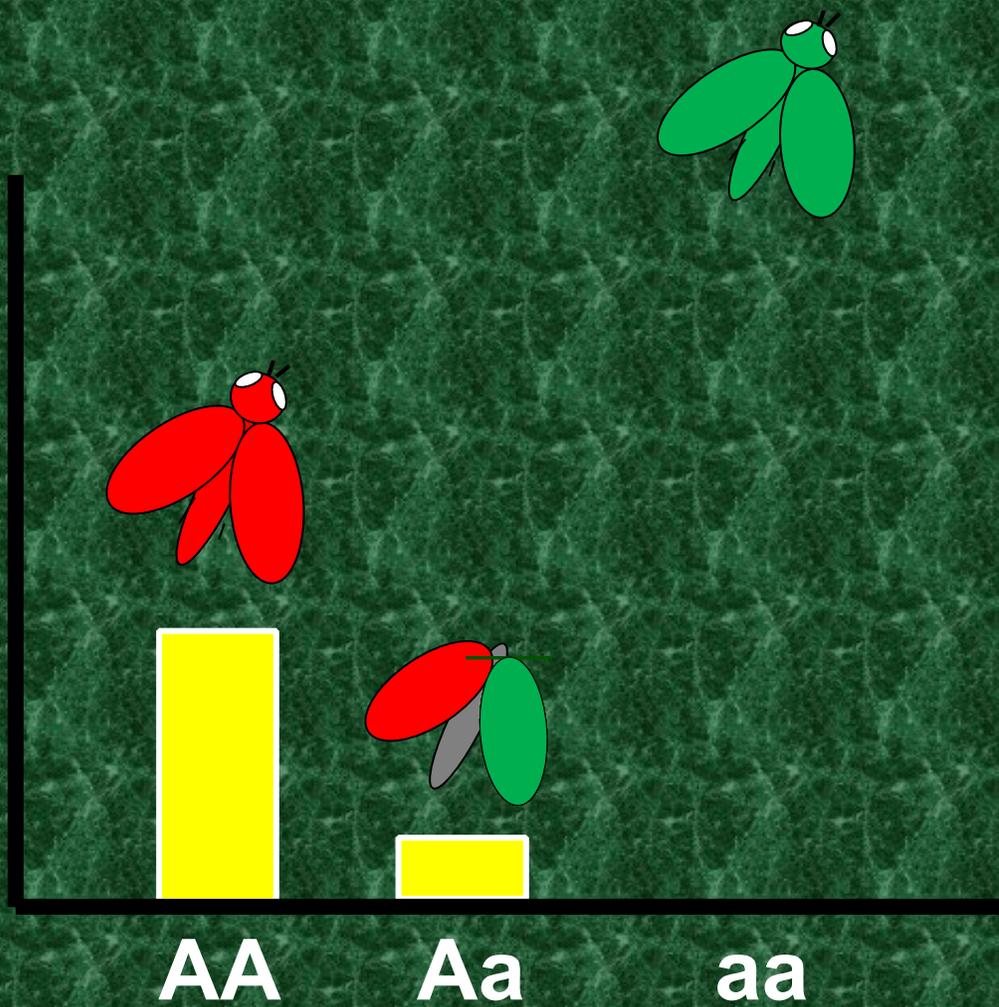


A transgenic Individual is likely to mate with another transgenic individual

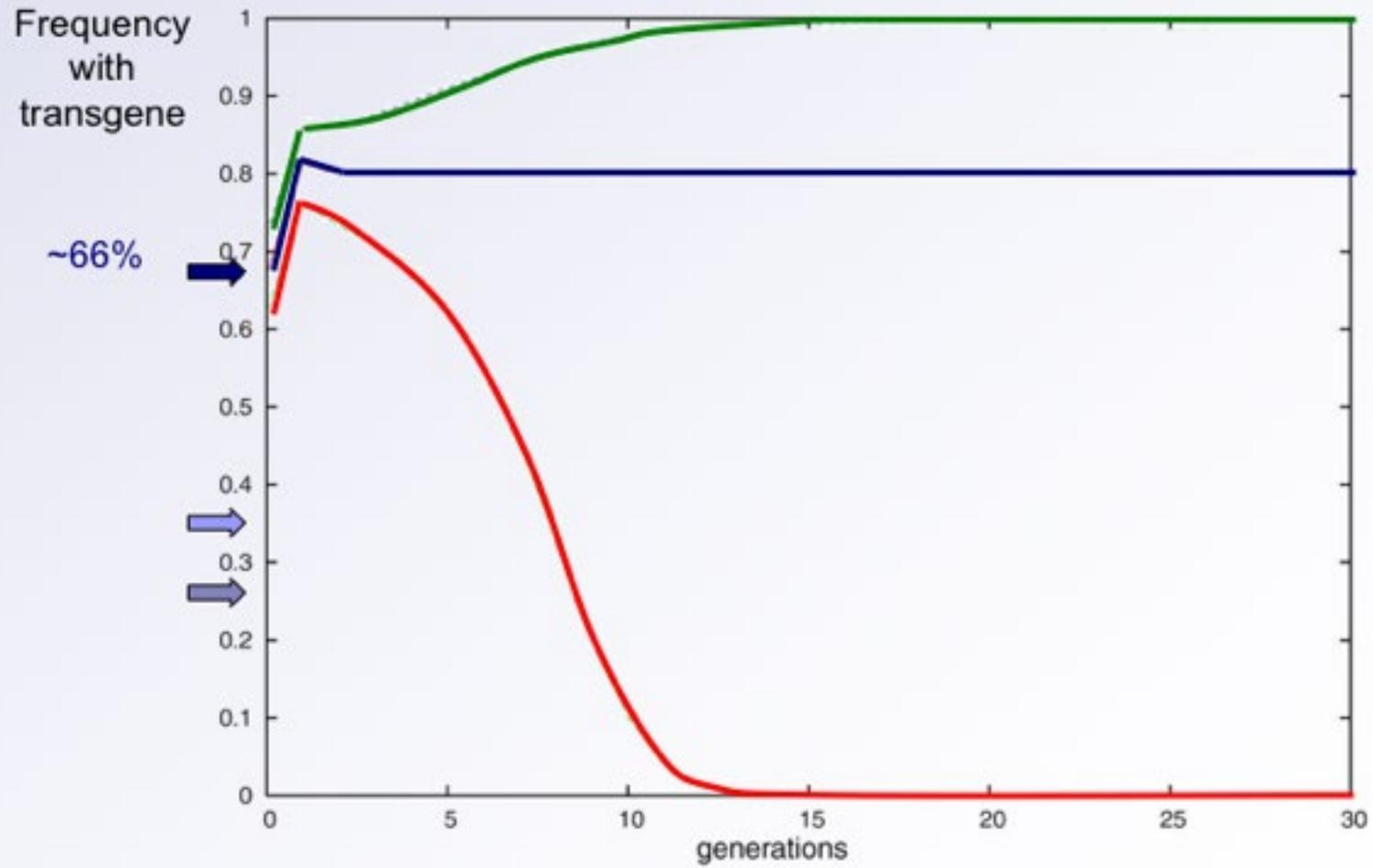


A wildtype individual is likely to mate with a transgenic individual



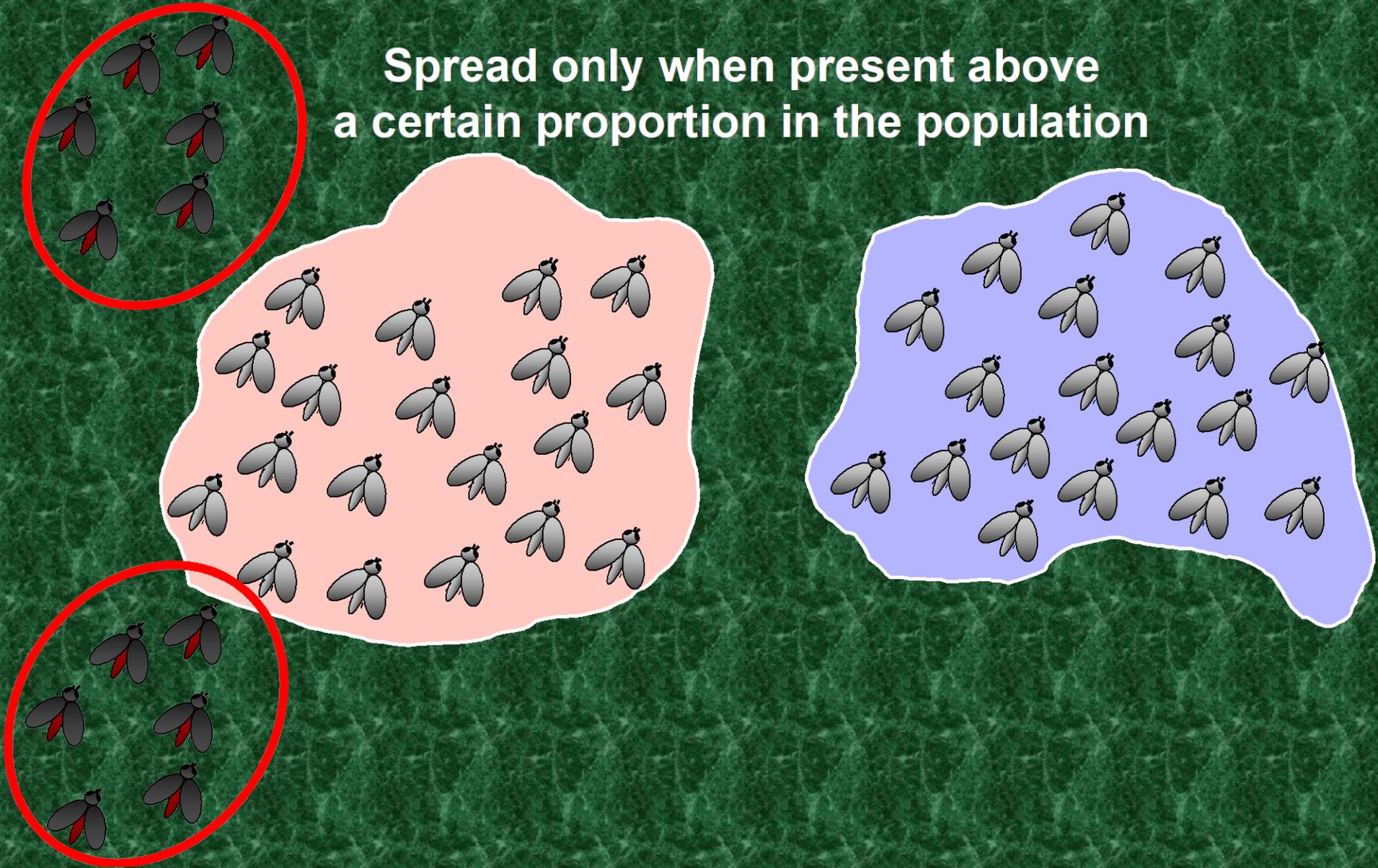


Engineered Underdominance – 20% cost per construct



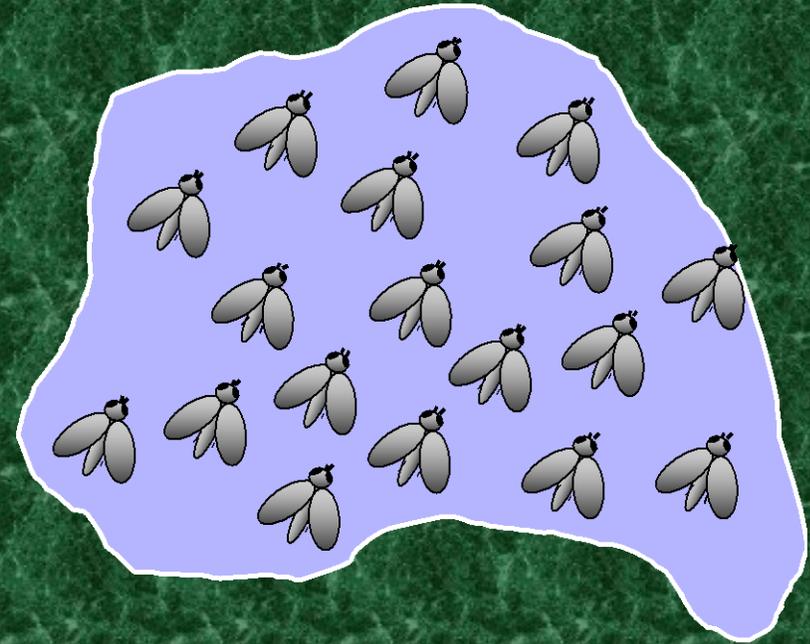
Using Underdominance as gene drive

Spread only when present above
a certain proportion in the population



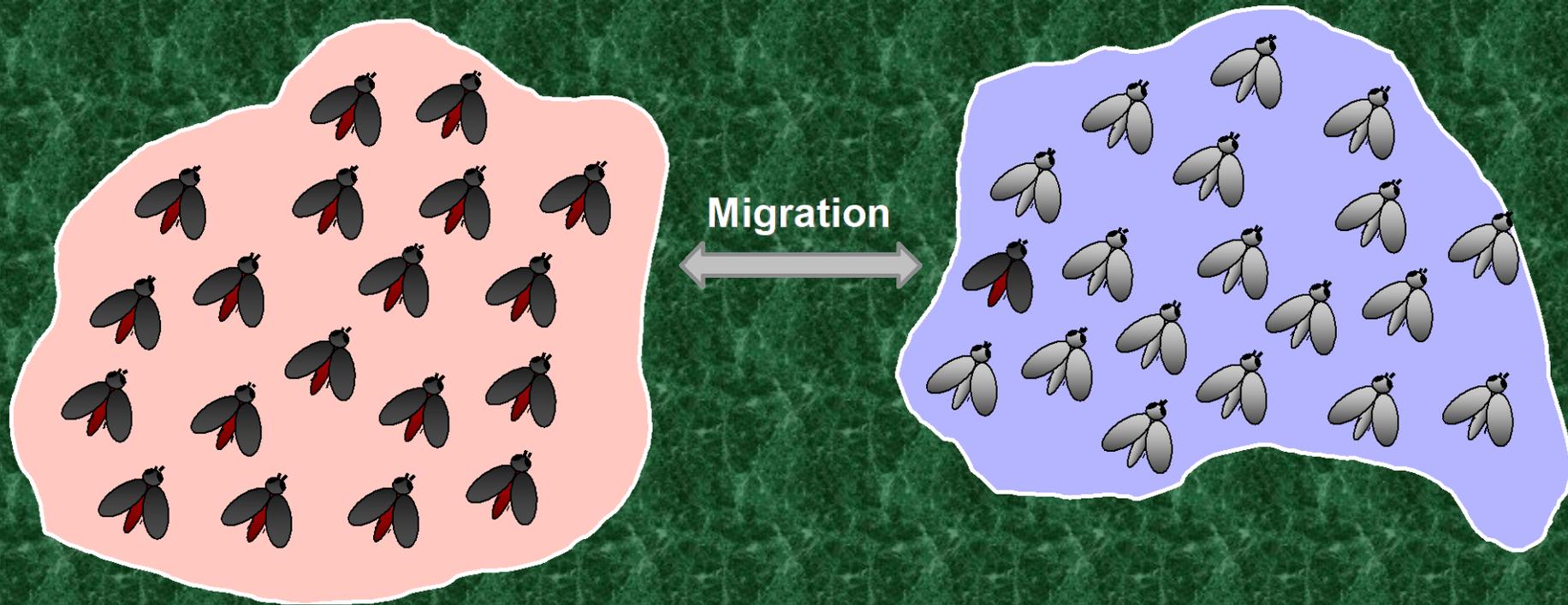
Using Underdominance as gene drive

Spread only when present above
a certain proportion in the population

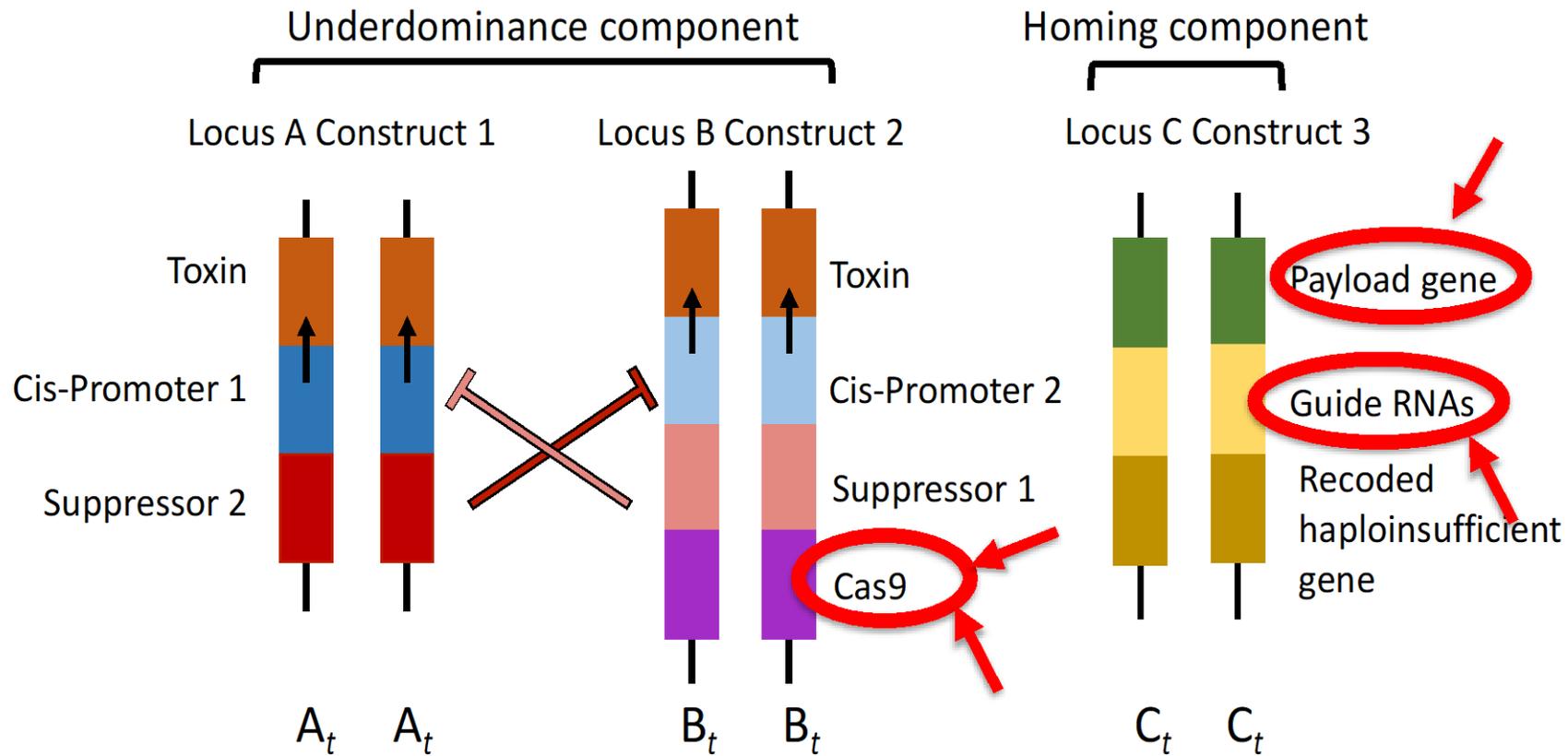


Using Underdominance as gene drive

Depending on how high the threshold is,
they can remain localized

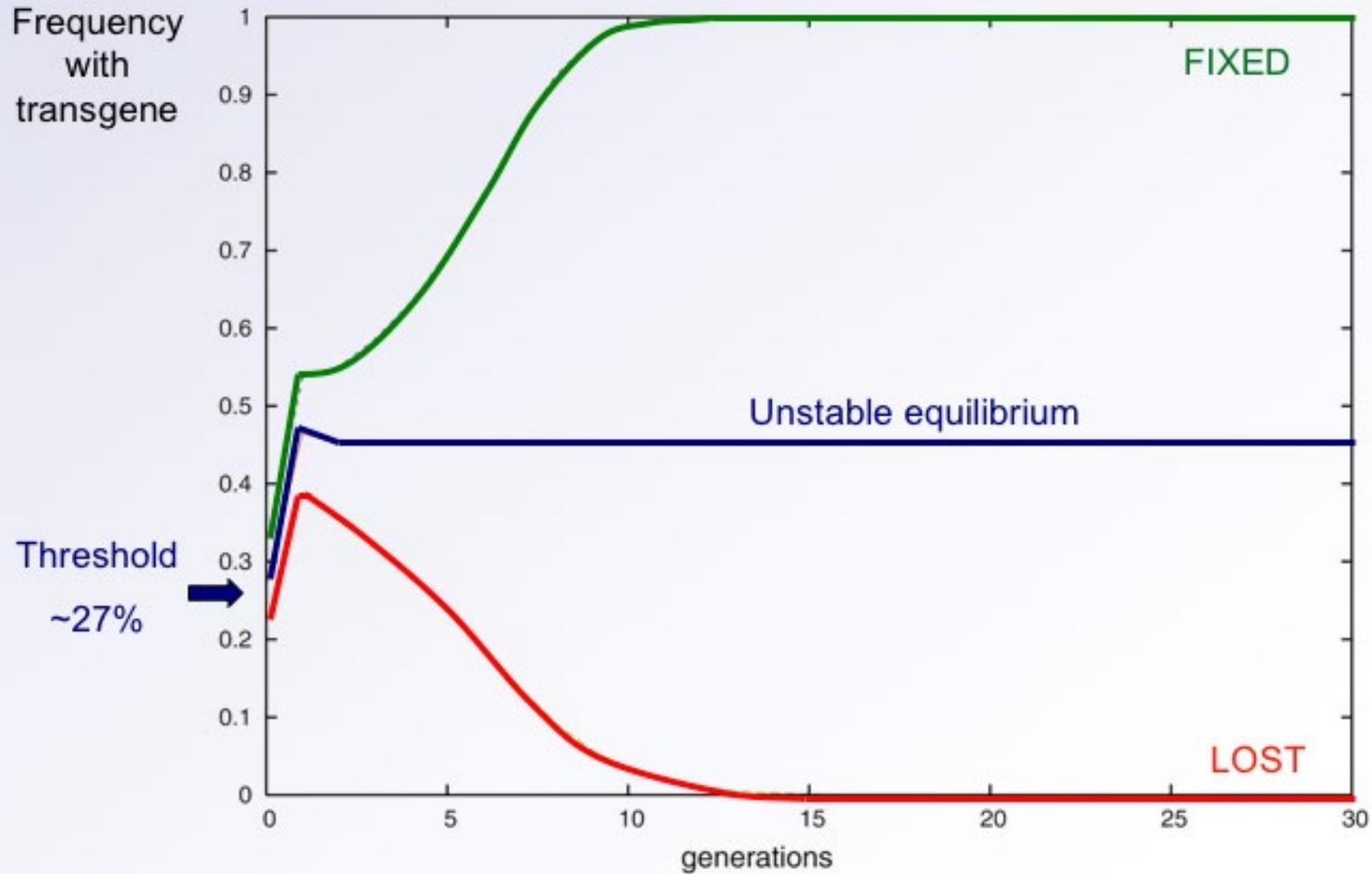


A Underdominance Tethered Homing Drive



Sumit Dhole

Engineered Underdominance



Drive Category	Threshold	Can spread high fitness cost	Temporally limited	Spatially limited	Resistance to drive
Standard Homing Drive	No (except special cases)	Yes	No	No	Yes In most cases
Cleave/Replace TARE/Medea	Low- if no fitness cost	No	No	Depends on fitness cost	Possible
<i>Wolbachia</i>	Low- if no fitness cost	No	No	Depends on fitness cost	Yes
Killer-Rescue Split-Homing Daisy Chain	No	No	Yes	No	Possible
Underdominance	At least 27%	No	No	Yes	Possible
Tethered Homing (with Underdominance)	At least 27%	Yes	No	Yes	Yes In most cases



PHASE 1: STERILE MALE

PHASE 2: SELF-LIMITING

PHASE 3: SELF-SUSTAINING

Suppression

Resistance to Drive

Replacement

Breakdown in
Pathogen Control