TARGET MALARIA

A Vector Control Research Alliance

Usefulness and limitations of a gene drive approach to vector-borne diseases control

Maria Vittoria Mancini

Polo GGB

Vector- borne diseases

Vector-borne diseases account for more than 17% of all infectious diseases, causing more than
700 000 deaths annually.

These diseases profoundly restrict socioeconomic status and development in countries with the highest rates of infection.

Current methods of control (Insecticide Treated Nets, Indoor Residual Spraying)

are good but **insufficient**.

Additional cost-effective & sustainable vector control methods are needed.

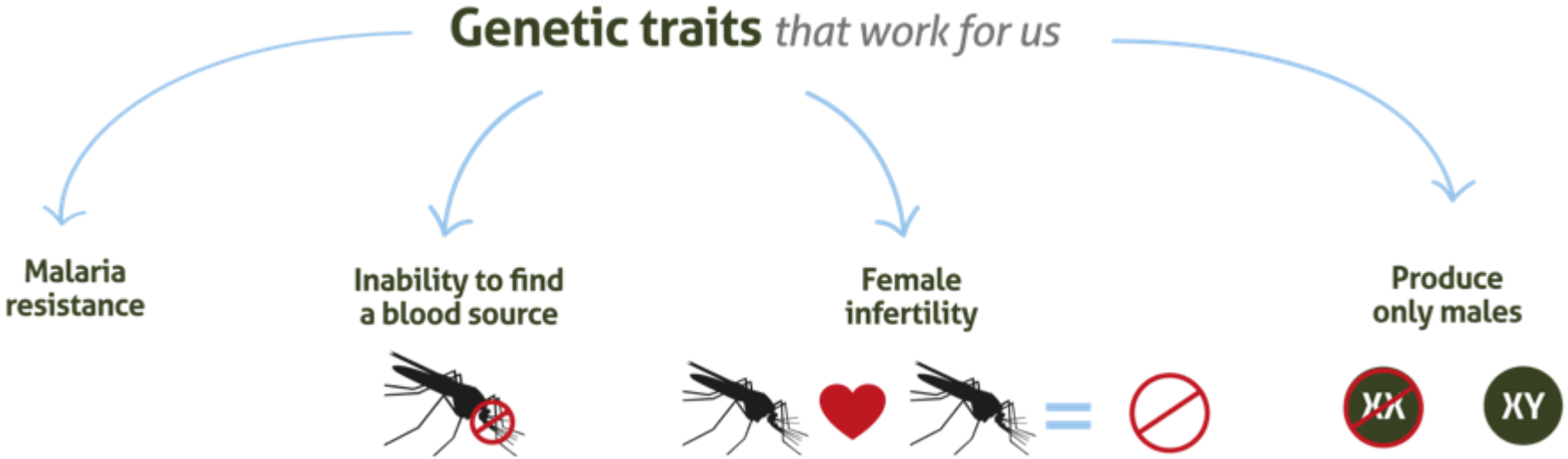
TARGET MALARIA

Gene drives for vector control

TARGET MALARIA

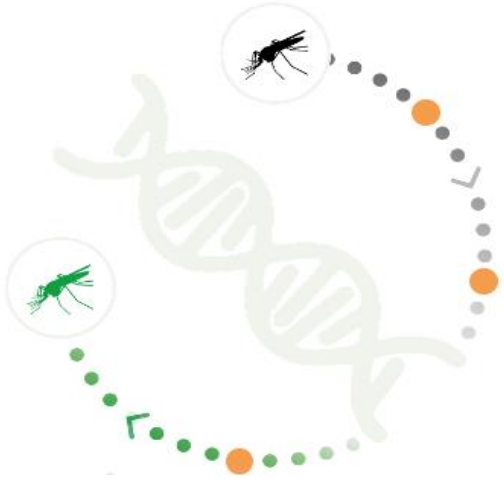
Genetic control to stop vector-borne diseases

Genetic control: the introduction of modified mosquitoes into a population to reduce or eliminate a disease



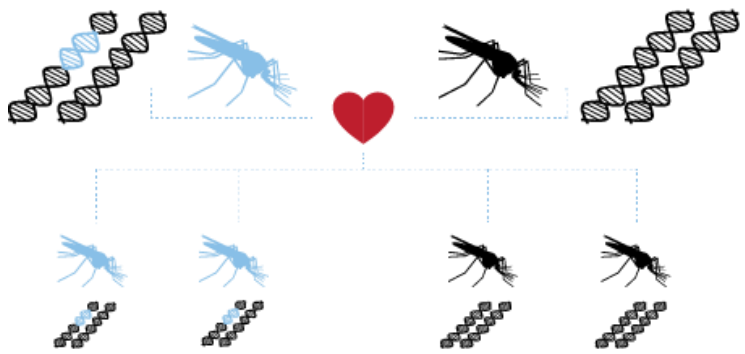
TARGET MALARIA

What is gene drive?

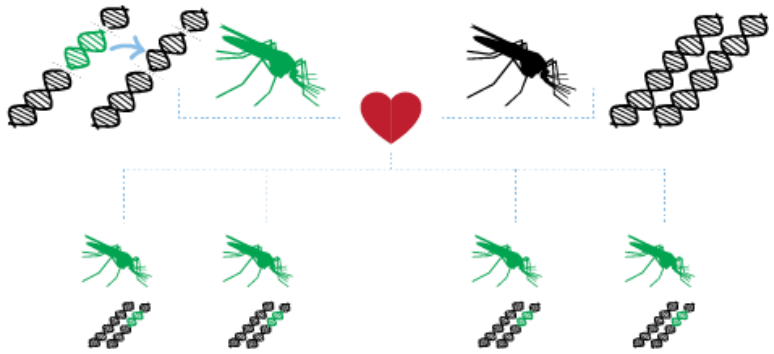


By using DNA-cutting enzymes called **nucleases**, it is possible to modify mosquito genes in a very precise way.

Most **genes** *are* **inherited** *half the time*



Driving genes *are* **always inherited**

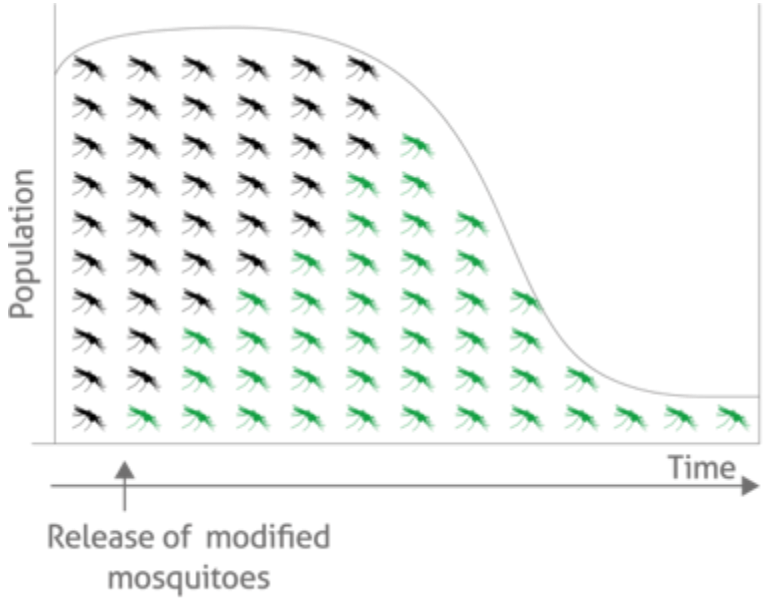


TARGET MALARIA

Options for genetic control of mosquito-borne infectious diseases

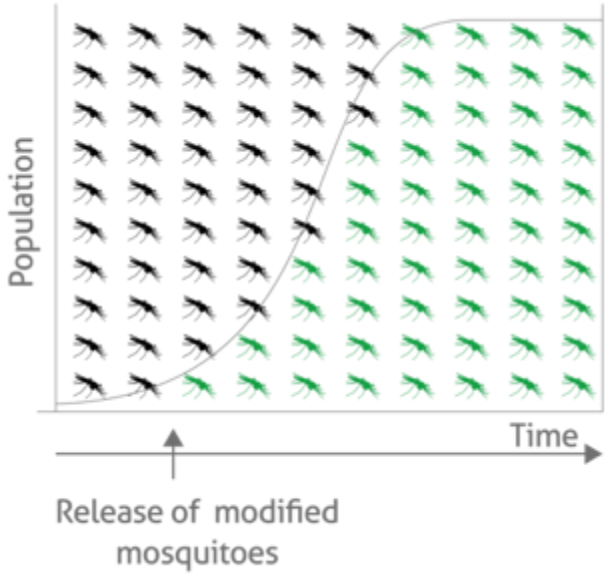
Population suppression

Releasing modified mosquitoes into the population can cause transient or permanent population suppression



Population replacement

Releasing modified mosquitoes into the population can lead to the spread of a gene that blocks malaria transmission



Gene drive can be used for **both approaches**. It allows the genetic modification to spread through a population in an efficient way.

TARGET MALARIA

Advantages

TARGET MALARIA

It has the potential to reduce mosquito populations and diseases transmission

- reduce the economic and human cost of these diseases
- reduce the environmental impact of invasive species

TARGET MALARIA

Long term approach

- More effective than traditional control interventions, e.g. insecticides
- Compatible with and helpful to other interventions

Self-sustaining and widely applicable

- Ability to establish in the environment and spread

Species-specific

- Reduced undesired effects on non-target organisms compared to conventional methods

Accessible

- Effective at low prevalence
- Easy to deliver /minimal infrastructure requirements
- No need of human behavioural changes

TARGET MALARIA

Limitations

TARGET MALARIA

Reduced efficacy of the technology

Genetic resistance

Drive-mediated genome alternations are expected to select resistance on each organisms on a evolutionary timescale. The evolution of resistance traits can prevent the driver from spreading.

- Mosquito/pathogen resistance: target highly conserved sites and processes at multiple sites/stages

Fitness costs

Gene drive individuals show strongly reduced fitness traits

- Improve the gene-drive technology or the target gene

TARGET MALARIA

Public perception and ethical concerns

1

Ethical concerns

The perception that the technology is an interference with nature.

- Public engagement
- Appropriate decision-making processes
- Benefit sharing

2

Safety of the technology

The risk that gene drives are difficult to stop if unexpected effects might occur during developmental phases

- Development of a safe and efficient technology through responsible science and thorough risk assessments
- Mitigation strategies

3

Lack of adaptive governance

The novelty and the rapid progress in gene drive research created a gap in international legislations

- Development of guidelines and recommendations (by scientists and independent regulatory authorities)

4

Transboundary movements

The potential to spread across national borders, resulting in international regulatory incidents.

- Implementation of supranational regulations

TARGET MALARIA

Ecological impacts

Releasing gene-drive mosquitoes for population suppression could cause long-term disruption in the ecosystem?

- **Ecological studies are specifically addressing these questions**
- *An. gambiae* is small fraction of invertebrate biomass
- Not known to be specialist pollinator, not 'keystone' species (in the food-chain, ecosystem)
- Largest ecological effect may be through reduction in malaria (i.e., same as bednets, etc.)

TARGET MALARIA

Key takeaways

The need for additional innovation in vector control interventions is increasingly apparent.

A transparent, inclusive and well-informed discussion for a responsible evaluation and development for genetic control technologies is crucial.

This discussion needs to consider the risks and benefits of this technology, together with the risks and benefits of maintaining the status quo .

TARGET MALARIA

Acknowledgements

"Target Malaria receives core funding from the Bill & Melinda Gates Foundation and from the Open Philanthropy Project Fund, an advised fund of Silicon Valley Community Foundation"

BILL & MELINDA GATES foundation

Open Philanthropy Project

TARGET MALARIA

TARGET MALARIA

A Vector Control Research Alliance

Thank you

TargetMalaria.org